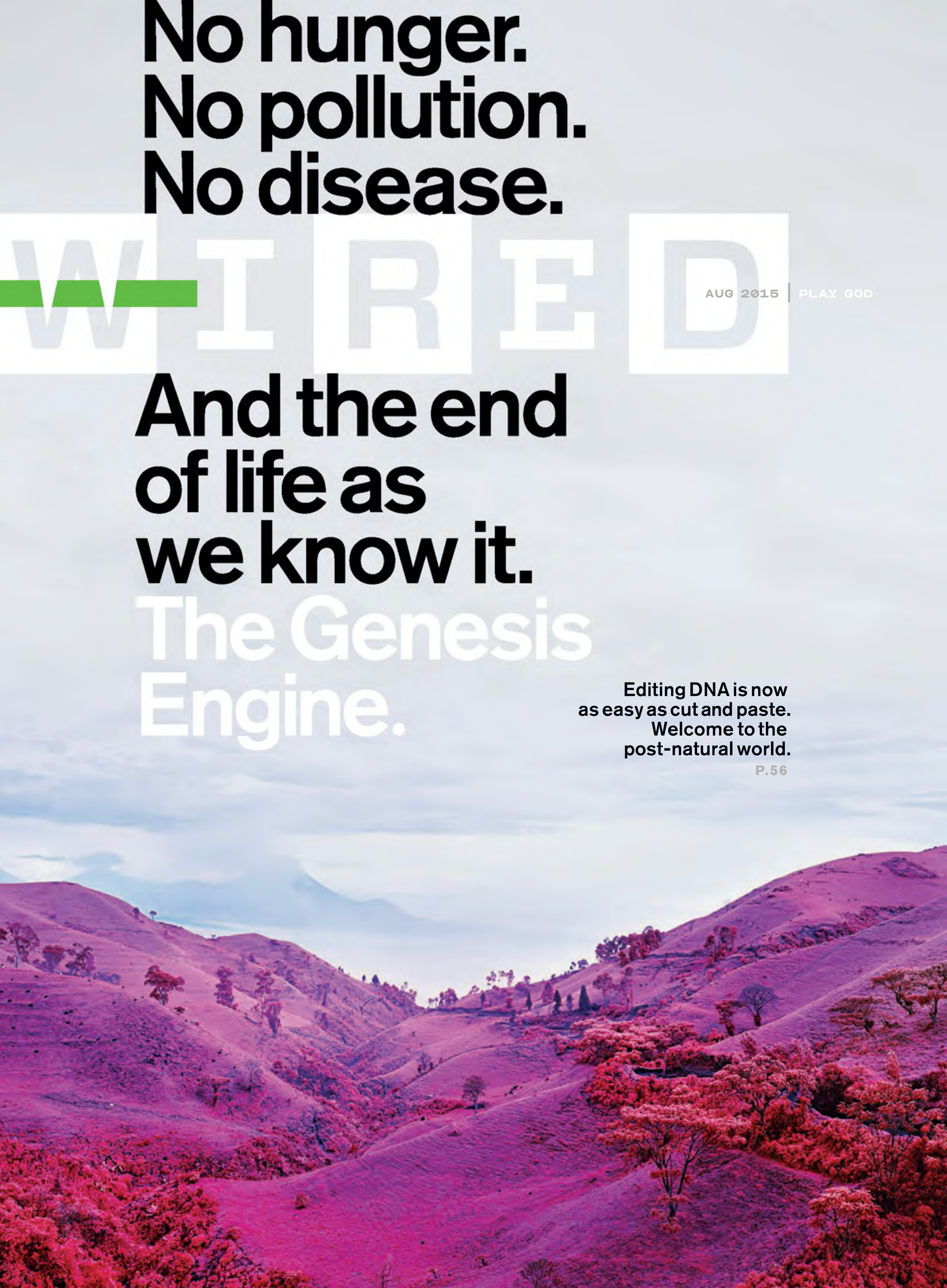

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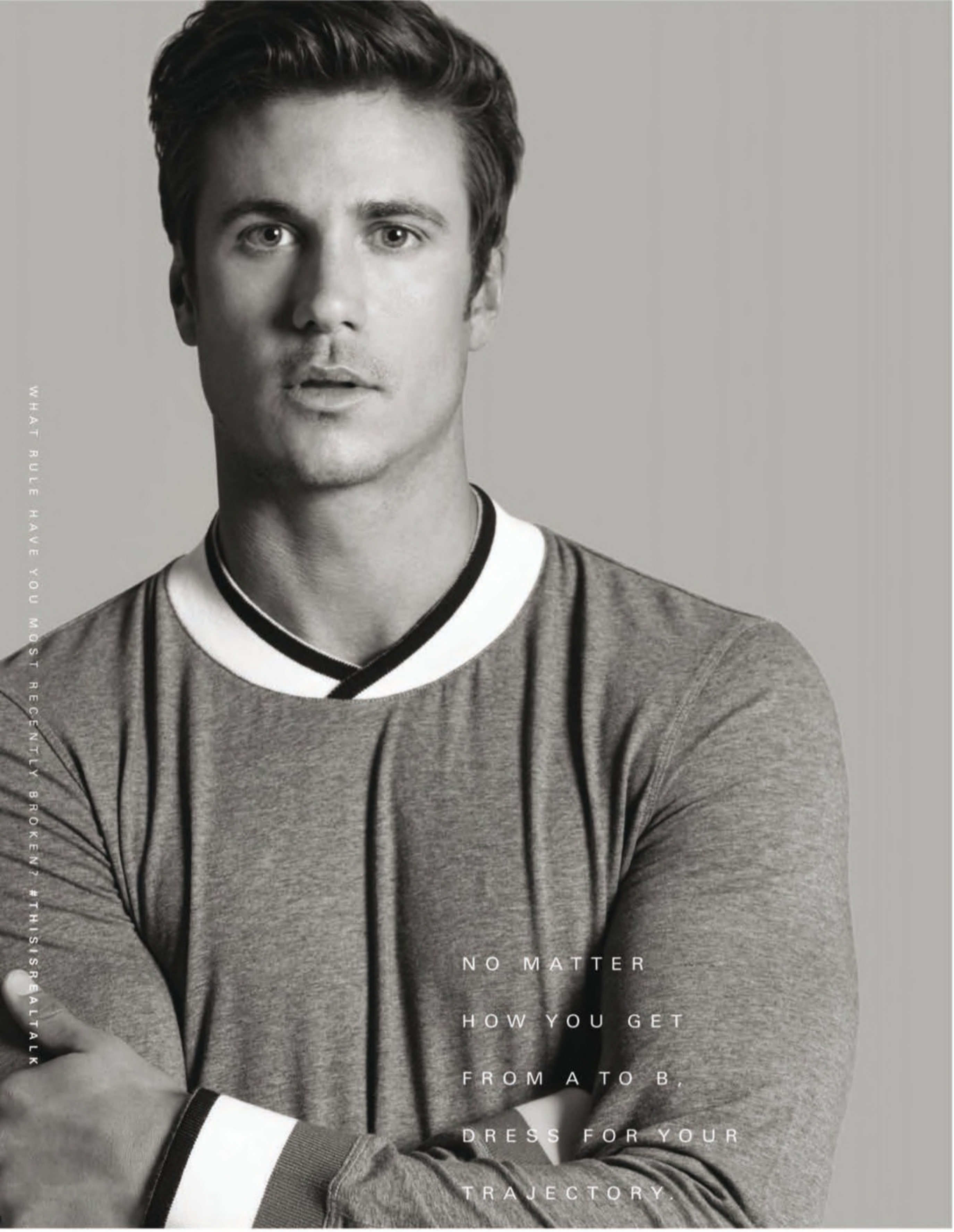
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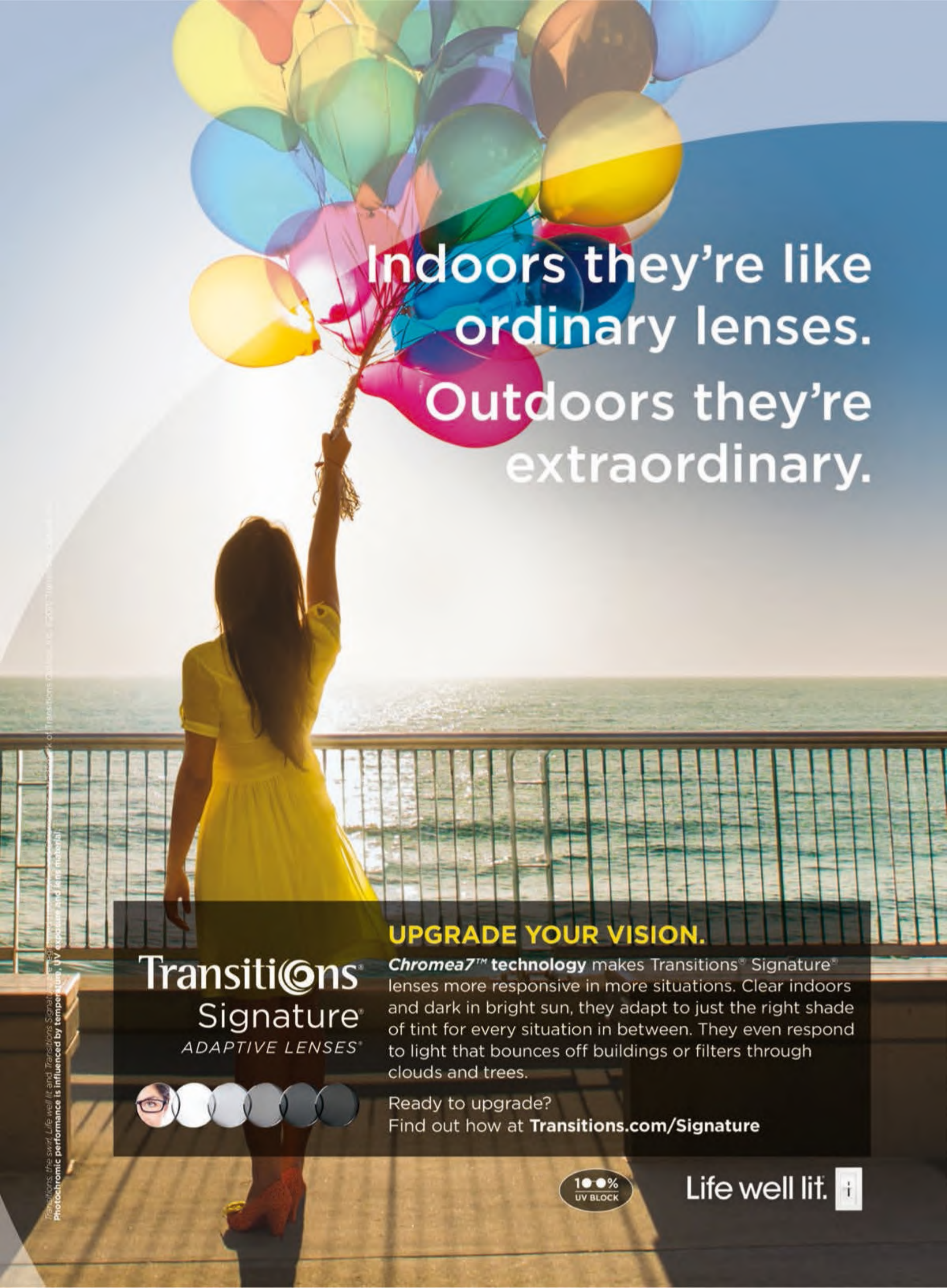
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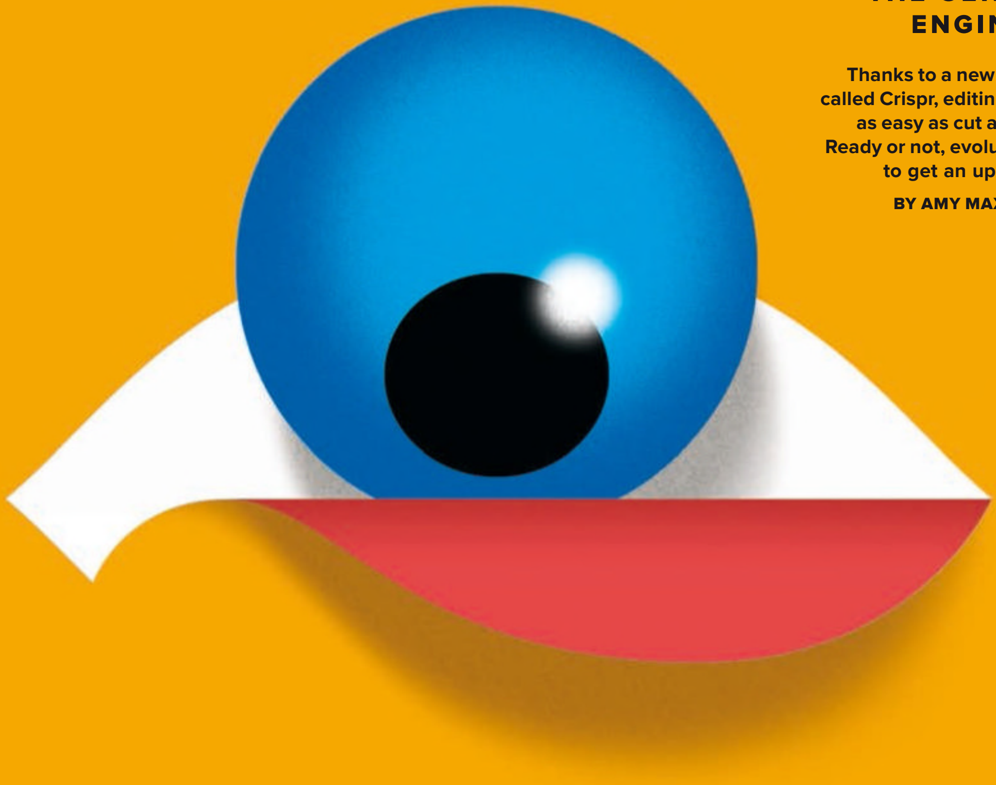
THE GENESIS ENGINE

Thanks to a new technique called Crispr, editing DNA is now as easy as cut and paste. Ready or not, evolution is about to get an upgrade.

BY AMY MAXMEN



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Secret Weapon

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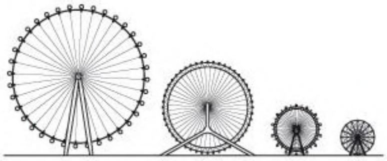
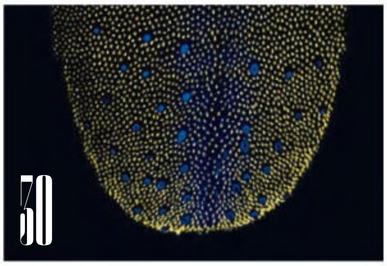


The Mouse-Tongue Trap
A rig that helps scientists understand how flavors are detected



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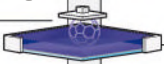

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ON THE COVER
Photograph by Richard Mosse

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VIDEO

Secret Weapon

WIRED senior writer Andy Greenberg put DIY gunsmithing to the test as he tried three ways of building an untraceable AR-15 semiautomatic rifle—a so-called ghost gun—while skirting all gun control laws. Read the story on page 76, and watch him assemble the rifle on WIRED.com.

ON THE WEB: video.WIRED.com

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Back to School

Applications are being accepted for a new online master's degree offered by the University of Southern California in partnership with WIRED. Students in the Master of Science in Integrated Design, Business and Technology program will learn deep skills plus the ability to work fluidly in all three disciplines.

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GIF and a Graf

Keeping up with TV is tough. What if you just want to see that one scene everyone's talking about? Our GIF and a Graf series gives you the best GIF from the latest episode of, say, *Wet Hot American Summer* (above) and a paragraph about why people freaked out over it. There, we just saved you an hour. **ON THE WEB:** WIRED.com/tag/gif-and-a-graf/

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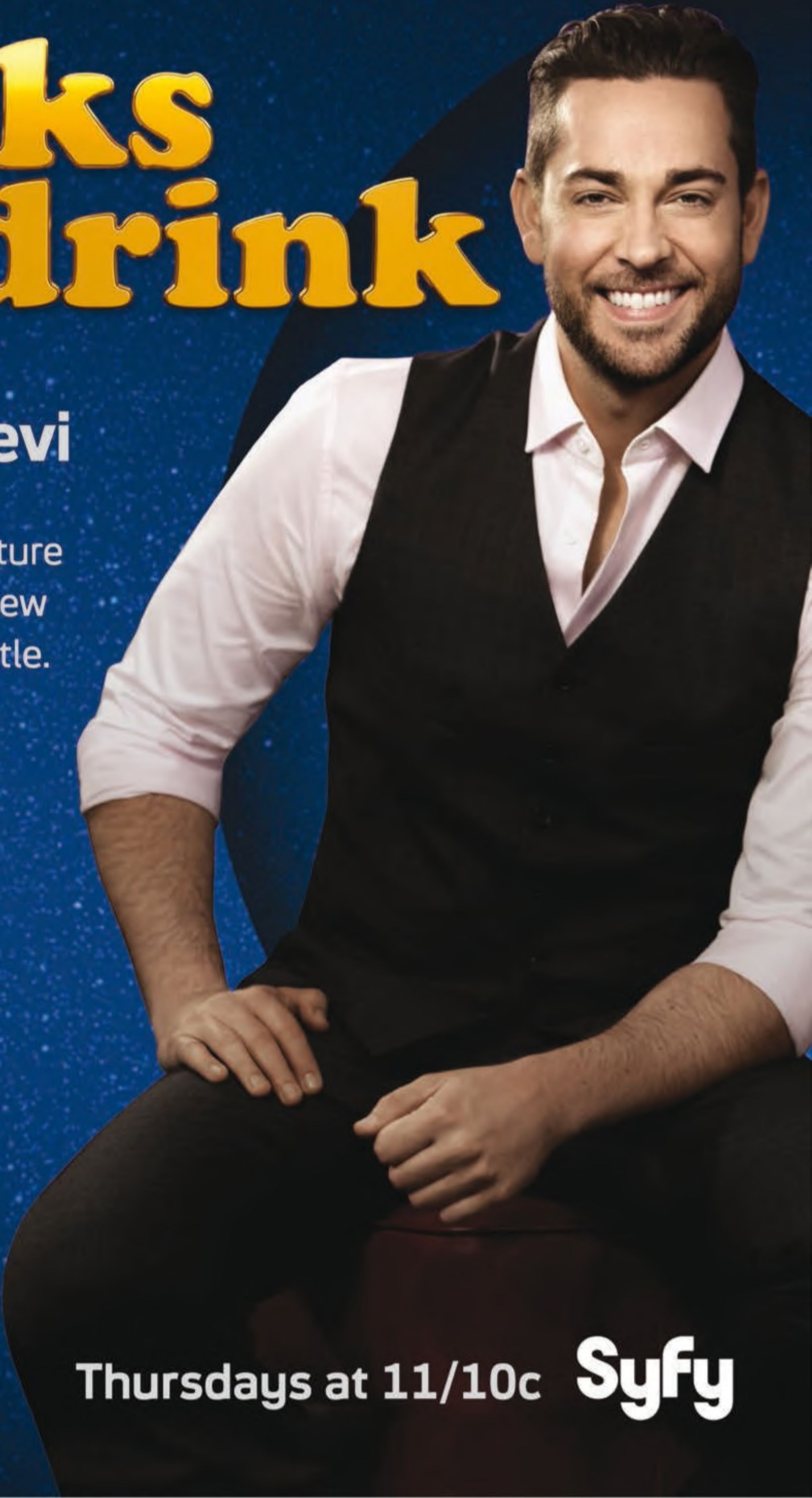

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THE HOUSE THAT GEORGE BUILT

The special effects studio created by George Lucas has defined the look and feel of movies since it was founded back in 1975. Scores of people have shaped Industrial Light & Magic over the years, and for its 40th anniversary, Alex French and Howie Kahn interviewed them all—not just the Lucases and the Spielbergs, but the model makers and sound designers who've had a hand in creating some of the most enduring icons in cinematic history ("Inside the Magic Factory"). What would the world look like without ILM? Who cares—it's not a world we'd want to live in.

RE: "INSIDE THE MAGIC FACTORY"

"PERHAPS THE COOLEST WIRED COVER. ALSO, SHOUT-OUT TO BUMBLEBEE IN THE BACKGROUND."

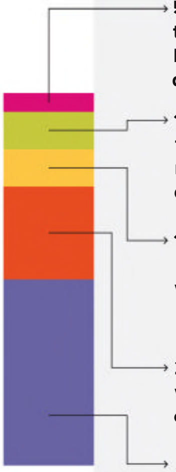
Alexandra Alonso (@denpostalonso) on Twitter

RE: "INSIDE THE MAGIC FACTORY"

"ILM at Kerner in San Rafael—definitely one of the coolest jobs I ever had. So grateful for the experience. I remember the parties in the Pit, hijinks in the Toy Bay, and long, long hours at the job that never once felt like work—surrounded by the brightest, most creative people on the planet at the time. So much absolutely groundbreaking stuff going on around you at every moment, yet you never became inured to it. Thanks, George!"

notfamous on WIRED.com

READERS SHARED THEIR FAVORITE LINES FROM THE ILM ORAL HISTORY ONLINE. HERE'S A BREAKDOWN.



5% "Forget the Industrial and the Light—this is going to have to be Magic. Otherwise we're doomed." —George Lucas

10% "I don't remember how I got the fire out, but I almost destroyed my family's house. And now I'm doing *Star Wars*." —Rian Johnson

10% "I always thought that if ILM had run the space agency we'd have colonized Mars by now." —Steven Spielberg

25% "I used to serenade the machines with my bagpipes so they wouldn't crash." —Steve "Spaz" Williams

50% "Someday, I hope, Marvel will make a new version of *Howard the Duck*, and you'll see it could be a good movie. A digital duck will make that thing work." —George Lucas

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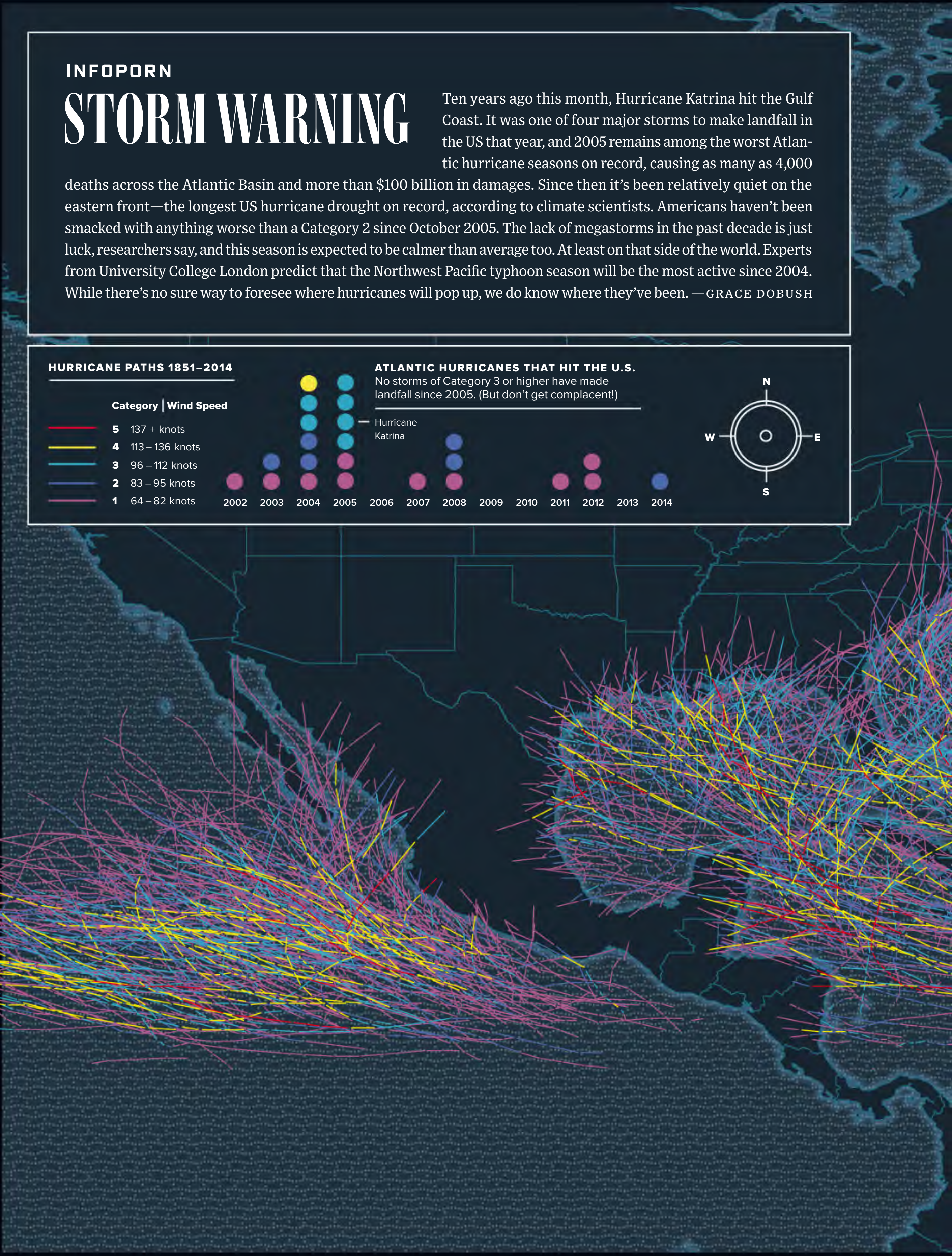
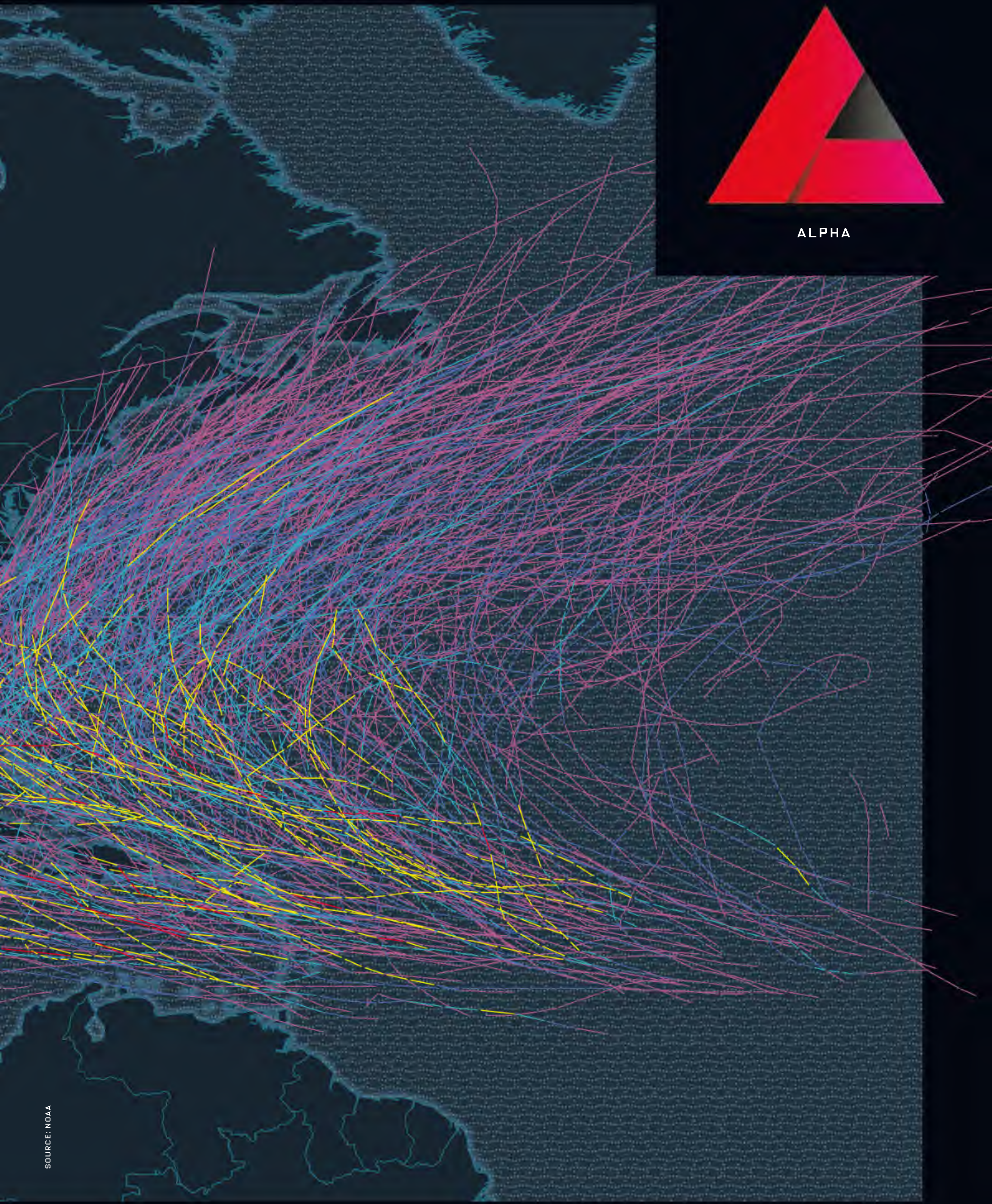
STORM WARNING

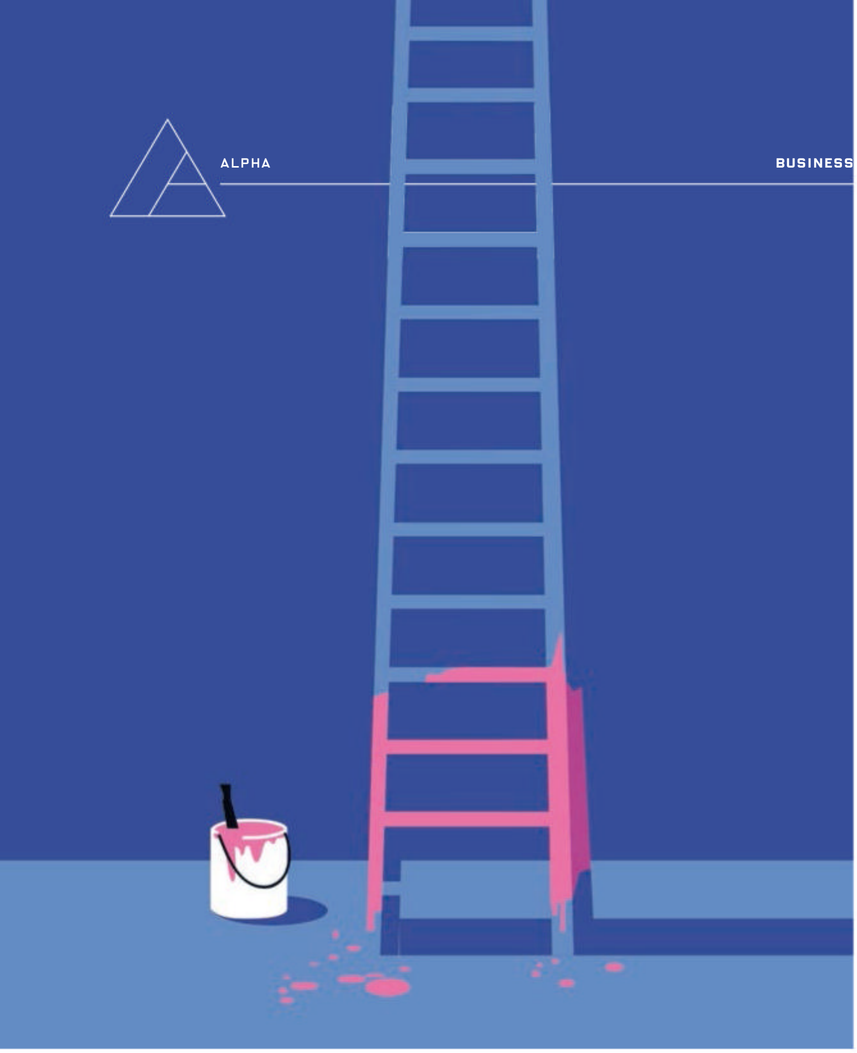
Ten years ago this month, Hurricane Katrina hit the Gulf Coast. It was one of four major storms to make landfall in the US that year, and 2005 remains among the worst Atlantic hurricane seasons on record, causing as many as 4,000 deaths across the Atlantic Basin and more than $100 billion in damages. Since then it's been relatively quiet on the eastern front—the longest US hurricane drought on record, according to climate scientists. Americans haven't been smacked with anything worse than a Category 2 since October 2005. The lack of megastorms in the past decade is just luck, researchers say, and this season is expected to be calmer than average too. At least on that side of the world. Experts from University College London predict that the Northwest Pacific typhoon season will be the most active since 2004. While there's no sure way to foresee where hurricanes will pop up, we do know where they've been. —GRACE DOBUSH



VALERIO PELLEGRINI AND MICHELE MAURI



SOURCE: NOAA



START SMALL

To increase diversity in Silicon Valley, one company has a plan: Get those tech firms while they're young.

DESPITE BIAS-BUSTING workshops and pledges of millions of dollars, Silicon Valley is still overrun by white dudes. A year after Google and Facebook released their damning diversity reports, the percentage of women at those companies is still around 30 percent. For African Americans and Hispanics, it's a pathetic 2 percent and 3.5 percent. And those are the big companies, which can afford heads of diversity and fancy data-mining programs. But Nathalie Miller thinks she's hit upon a scheme that can help keep startups from falling into the white-guy trap. ¶ Miller is the CEO of Doxa, which uses OkCupid-style algorithms to match women with startups. Its anonymous surveys, distributed at companies like Instacart and Lyft, look at data, both quantitative (pay gaps, say) and qualitative (are women expected to pick up the "office housework" like taking notes and planning events?). Job candidates can then get a sense of the culture, while managers can use the intel to target areas for improvement. ¶ Because even when a company is growing fast, Miller argues, it can make deliberate hiring choices. "You don't have to wait until you're enormous to think about inclusion," she says. ¶ It's a smart move: According to McKinsey, companies in the top quartile for racial and gender diversity are (respectively) 35 and 15 percent more likely to have better financial returns than their peers. In other words: If your oh-so-great "meritocracy" leads to a homogeneous workforce, you're leaving money on the table. —DAVEY ALBA

JARGON WATCH

Lomekwian
adj. / ˌlō-'me-kwē-ən /

The first known toolmaking culture. Lomekwian stone implements found at a Kenyan site called Lomekwi 3 are 3.3 million years old, probably more ancient than the *Homo* genus. Whoever used the tools must have been strong: The biggest weigh more than 30 pounds.

thought vector
n. / 'thȯt 'vek-tər /

A sequence of numbers that describes the meaning of an entire sentence. Google scientists use this number sequence (or vector) as an abstract representation of the thought encoded by the words. In the future, thought vectors could help computers to communicate and reason like humans.

autoendoliths
n. pl. / ˌȯ-tō-'en-də-liths /

Microbes that fabricate their own limestone homes. Found near undersea methane vents, autoendoliths are the only organisms known to encapsulate themselves in rock—the kind of trick that might help microbes survive on Mars. The name means "self within stone."

cattle laundering
v. / 'ka-təl 'lȯn-də-riŋ /

A tactic for evading grazing regulations in the Brazilian rain forest. Cattle illicitly raised on restricted land are laundered by being herded onto licensed ranches that can legally sell them to slaughterhouses. The loophole contributes to deforestation of the Amazon.
—JONATHON KEATS
jargon@WIRED.com

ILLUSTRATION BY THOMAS POROSTOCKY

BEN WISEMAN

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50

WEIGHT IN TONS OF THE C-130, WHICH PULLS 2 G'S DURING SHOWS.

DAYMON GARDNER

ALPHA GEEK

FEARLESS FLIER

THE BLUE ANGELS GET A BOLD NEW PERFORMER

BEFORE SHE ENROLLED in the Naval Academy, Katie Higgins considered becoming a nun. But she comes from a family of military pilots, including her father and both grandfathers—so the pull of aviation was strong. Now the 28-year-old Marine captain is the first woman to fly with the elite Blue Angels aerobatics squadron during shows. ¶ Higgins trained to fly C-130s, the US military's workhorse cargo plane, then deployed to Afghanistan and Uganda. But growing up, she had always admired the Blue Angels, so with a little encouragement from the team's head C-130 pilot, she applied. Now Higgins pilots the Angels' support plane, an older C-130 dubbed Fat Albert. ¶ Her main duty is shuttling the squadron's 35,000 pounds of equipment and 40 crewmembers. But during air shows, she flies an eight-and-a-half-minute solo. It's a crowd favorite. Higgins executes "flat pass" flyovers at 50 feet, simulates tactical landings, does nosedives, and slams the propellers into reverse—the C-130 can famously stop very, very short. When she touches the plane down, she pops a wheelie and taxis backward. And at 24 years old, Fat Albert isn't exactly new; the C-130s Higgins flew for the Marines were fresher, with more advanced gear. Though Higgins is the first woman to fly during a Blue Angels show, the squad has had female officers for 46 years—19 other women serve on the team. "They're all setting such a great example for a future generation of women who are considering technical fields," Higgins says. ¶ Besides wheelies, she's trained in aerial refueling, deliveries, and, most challenging of all, close air support to protect forces on the ground. So maybe it's no surprise that Higgins hopes to get back overseas. "It's an extremely versatile aircraft," Higgins says. "I'm not pigeonholed into one mission." For now, though, she flies with the Angels 300 days a year. —LYDIA BELANGER

GOOGLE BUILT A SATELLITE CAMPUS HERE IN **2006**. // LOCATED IN "THE NAPA VALLEY OF BEER," BOULDER IS HOME TO **22 BREWERIES**. // BOULDER'S TALLEST FLATIRON (IT'S A ROCK FORMATION, NOT A BUILDING) SOARS TO **7,628 FEET**. // THE **SECOND AMERICAN ASTRONAUT** IN ORBIT, SCOTT CARPENTER, GREW UP HERE.

WIRED CITIES

BOLT FOR BOULDER

ATOMIC CLOCKS AND IRON MEN

The recently opened Highway 93 underpass connects the prairie trails to the east with the foothill trails to the west.

IT'S EASY TO DISMISS Boulder as a granola-sprinkled idyll, and it *is* a healthy kind of place: Triathletes flock here during the first week of August to compete in Ironman Boulder, a 2.4-mile swim, 112-mile bike ride, and 26.2-mile run past creeks and parks on the Boulder Creek Trail. But look closely and you'll see a city on the verge of transformation. Thanks largely to startup accelerator Techstars, it is home to more than a hundred startups. From its gold-mining days to its rep as a hippie haven, Boulder has championed discovery, and its entrepreneurship scene underscores what residents already know: Boulder is a city of the future. —ALESSANDRA RAM

"My post–Ironman 2014 meal was a Rueben's Burger Bistro's buffalo meat burger with sweet potato fries. I also love their boneless buffalo wings. (All-white-meat chicken balls—no bones!)"

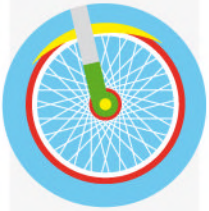
—Laura Bennett, professional triathlete

See

I. M. Pei designed the **National Center for Atmospheric Research**, nestled at the foot of the Rocky Mountains, to complement the surrounding rocks. **CU-Boulder's Heritage Center** houses a 1,200-pound Lego model campus, featuring a tree-climbing bear and the Foucault pendulum at the university's Gamow Tower. Tour the robotically operated **Celestial Seasonings tea factory**. Catch a Jenny Lewis show at the **Fox Theatre**, hailed by music snobs for its stereo four-way line array system.

Do

Rent an e-bike from local favorite **Optibike** and ride around the city's 52 miles of multiuse paths. Greet the Ironman champs at the finish line at **Pearl Street Mall**. Contemplate the power of cesium: The **NIST-F2 atomic clock**, which opened last year, operates out of the National Institute of Standards and Technology's Boulder campus. Take advantage of legalization with a limousine cannabis tour by **Green Tripz**, featuring intel on smoke shops and the best places to satisfy the munchies, like **Cheba Hut** or **Boulder Baked**.



Eat

Swing by the **Cup** for some banana bread, but secure your seat before the startup crowd moves in. The **Bitter Bar**, **Bramble & Hare**, and **T-Zero Lounge** in the St. Julien hotel all serve up craft cocktails and local beers. Or bike from brewery to brewery until you can't bike no more (at least not safely). And if you can manage to change out of your spandex, head to **Oak at Fourteenth** for locally sourced white asparagus and short ribs.

ILLUSTRATIONS BY PATRICK HRUBY; PORTRAIT BY KYLE HILTON

BENJAMIN RASMUSSEN

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LG G4

www.LG.com/G4

Qualcomm snapdragon

LG

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WHAT'S INSIDE

CALADRYL LOTION

ITCHY AND SCRATCHY NO-SHOW

Calamine

The itch-relieving action starts with this eponymous pink stuff, a cocktail of zinc oxide and a little iron oxide. This skin protector helps to dry the oozy, weepy blisters from the poison ivy/oak/sumac triple threat—and zinc can prevent mast cells from releasing itch-causing histamine. As for the "-dryl" in Caladryl? It comes from Benadryl, an antihistamine that was removed from the formula in the '90s because overapplication led to hallucinations in some kids.

Pramoxine HCl

Instead of an antihistamine, the current formula contains this local anesthetic. It interacts with nerve cell membranes to block movement of sodium ions, which transfer messages from one nerve to the next, all the way to your brain. If the ions can't pass through the membranes, your brain can't receive those itchy and scratchy signals.

SD Alcohol 38-B

Primarily a carrier for the other ingredients. (SD stands for specially denatured, which means regulatory agencies require the addition of gross-tasting stuff so you won't gulp it to get drunk.) But thanks to alcohol's low boiling point, it may contribute to itch relief: It evaporates readily, producing a cooling sensation.

Camphor

An aromatic compound, camphor has been used for medicinal purposes for more than a millennium. It can be extracted from the wood of the evergreen camphor tree. Researchers have only recently discovered how it produces a cool, tingly feeling: It binds to one of the same cold-sensitive receptors as menthol, raising the temperature threshold that signals "cool" and tricking your brain into experiencing a refreshing breeze.

Methylparaben, Propylparaben, Diazolidinyl Urea

An antimicrobial arsenal. Parabens are great preservatives, but they're better at killing fungi than bacteria. So diazolidinyl urea steps in to pick up the slack. It breaks down to release formaldehyde, which kills off microbes by attacking key protein structures.

Hypromellose, Xanthan Gum

These goopy hydrocolloids make for a thick lotion. Xanthan gum is a pseudoplastic—when you shake it up in the bottle, it becomes thinner and spreads easily, but once the solution settles it gets much more viscous. That means it'll stay on your mosquito bite longer, working hard to relieve your dermatologic torment.
—KATIE M. PALMER

STYLING BY ROBIN FINLAY

ADAM VOORHES

WELL ARMED

The LG Watch Urbane, the Genuine Smartpiece. Equipped with Android Wear, it can send texts, deliver notifications, give turn-by-turn directions, sync and play your favorite tracks, and more. With its interchangeable leatherstraps and classic gold or silver finishes, it proves the future of innovation can indeed be timeless.

androidwear

Genuine Smartpiece

LG Watch Urbane

LG

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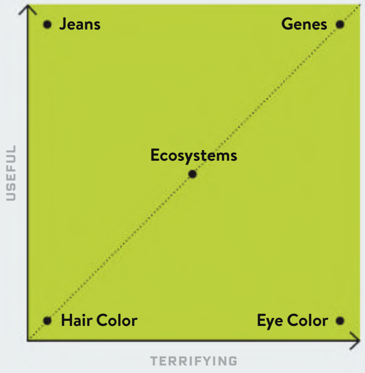
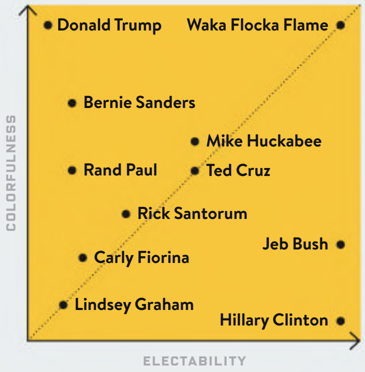
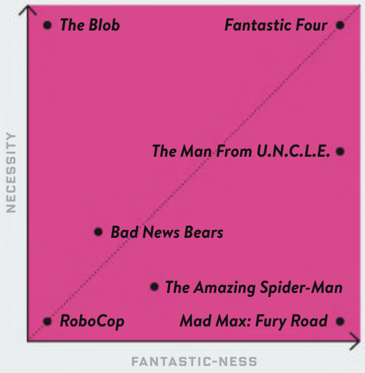
Things We Can Alter



2016 Presidential Candidates



Reboots



COURTESY OF PERKINS EASTMAN AND S9 ARCHITECTURE; FERRIS WHEEL ILLUSTRATIONS BY JASON LEE; CHARTGEIST CONTRIBUTOR: JON J. EILENBERG

FERRIS WHEELS GROW UP (AND UP)

STATEN ISLAND IS NEXT

THE 443-FOOT LONDON EYE was supposed to be temporary when it opened to ring in the millennium. But a funny thing happened on the way to slow, rotating views of London: People kept showing up. Fifteen years later, cities the world over are competing to build record-breaking observation wheels. And one engineering firm, Starneth, specializes in their design and construction. ¶ As with any supertall structure (the largest in the US need a Determination of No Hazard from the FAA), storm- and hurricane-strength winds and earthquakes pose the biggest risk to giant wheels. So Starneth tests components and scale models in wind tunnels to identify each wheel's unique drag and vibration characteristics. As for onsite positioning, an axis parallel to the wind is best, says Fraser Smith, a structural engineer who works on Starneth's wheels. ¶ Installation is so challenging that it can last six to nine months—nearly the time spent on the actual design. "With buildings, you start at the bottom and go up," Smith says. "With a wheel, we build it a piece at a time and rotate it." During this "clocking" process, Starneth uses temporary structures to hold prefabricated pieces in place until the wheel can support its own weight. ¶ The results will next be on display in Staten Island, where the $500 million New York Wheel will become the world's tallest (630 feet) when it's done in 2017—not bad for a structure that's more bridge (spokes are made of tensioned cable) or machine (huge wheels mean huge bearings) than building. "It's a scalable machine, so as the wheel gets bigger the mechanical aspects do too," Smith says. And, of course, so does the price. —MIKE OLSON

Riders will be able to see for 30 miles from the apex of the New York Wheel.

Iconic Wheels

Some of the world's coolest Ferris wheels, from mega to modest.

New York Wheel
Staten Island
(OPENING: 2017)
HEIGHT: 630 feet //
ROTATION TIME: 38 min

High Roller
Las Vegas (2014)
550 feet // 30 min

Singapore Flyer
Singapore (2008)
541 feet // 30 min

London Eye
London (2000)
443 feet // 30 min

Tianjin Eye
China (2009)
394 feet // 30 min

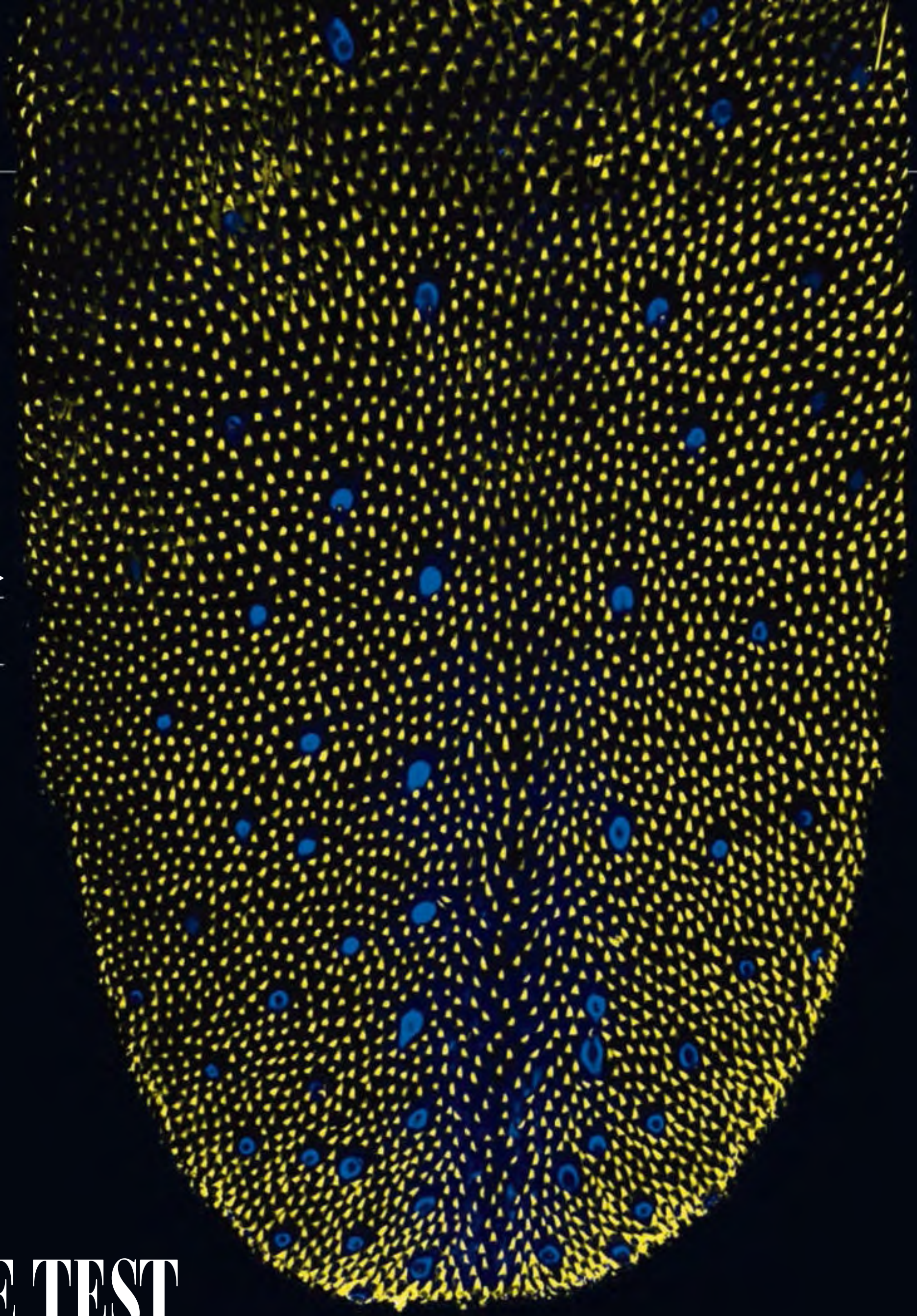
Cosmo Clock 21
Tokyo (1989)
369 feet // 15 min

Big O
Tokyo (2003)
263 feet // 15 min

Vienna Giant Ferris Wheel
Austria (1897)
212 feet // 12–15 min

Wonder Wheel
Coney Island, NY (1920)
150 feet // 3 min

TASTE TEST
A BETTER MOUSETRAP



Mouse Tongue

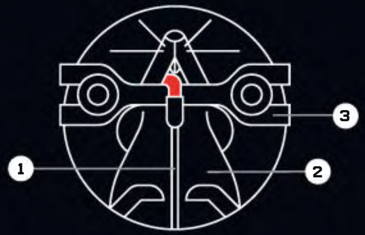
The blue dots are the taste buds. Once they absorb the sweetener and the dye, they'll start to glow green, and the sweetness-specific taste cells will glow brighter than the others.

It's tough to watch taste buds in action—you can't clamp a microscope onto a subject's tongue. As a result, researchers typically study taste cells in a petri dish. But for bioengineer Myunghwan Choi and his colleagues at Harvard, a disembodied taste bud is useless. "All the microarchitecture is destroyed," Choi says. And without the microarchitecture—from taste pores to capillaries—scientists can't fully understand how mice (and people) receive the flavor of Camembert at a molecular level.

So, to examine a live mouse tongue under a microscope, Choi's team invented an apparatus that wouldn't look out of place in *A Clockwork Orange*. First, researchers stain the mouse's tongue with dye formulated to glow under infrared light. Then they use a tiny suction hose to pull the anesthetized rodent's tongue out, and they steady it on a steel brace. And finally: lasers.

The researcher drips a bit of artificial sweetener onto the organ in question and beams it with infrared-laser light. When a taste pore absorbs the sweetener, the surrounding taste cells attuned to sweetness start to fluoresce. (Salt has the same effect but causes different cells to glow.) It's the first direct proof that taste cells specialize in the flavors they detect.

The laser technique Choi uses to observe tongue cells in action has already been used to observe neurons. So the next step is to use two laser-microscope setups (and one mouse) to film the tongue and the brain at the same time, revealing the complete mechanism of taste. Perhaps science will finally discover why Cheez Whiz is so popular.
—JONATHON KEATS



The Rodent Rig

[1] A tiny suction hose pulls out and holds the tongue of the **[2]** anesthetized mouse. It's kept steady on a **[3]** stainless steel brace.

ILLUSTRATION BY GORAN FACTORY; COURTESY OF HARVARD MEDICAL SCHOOL

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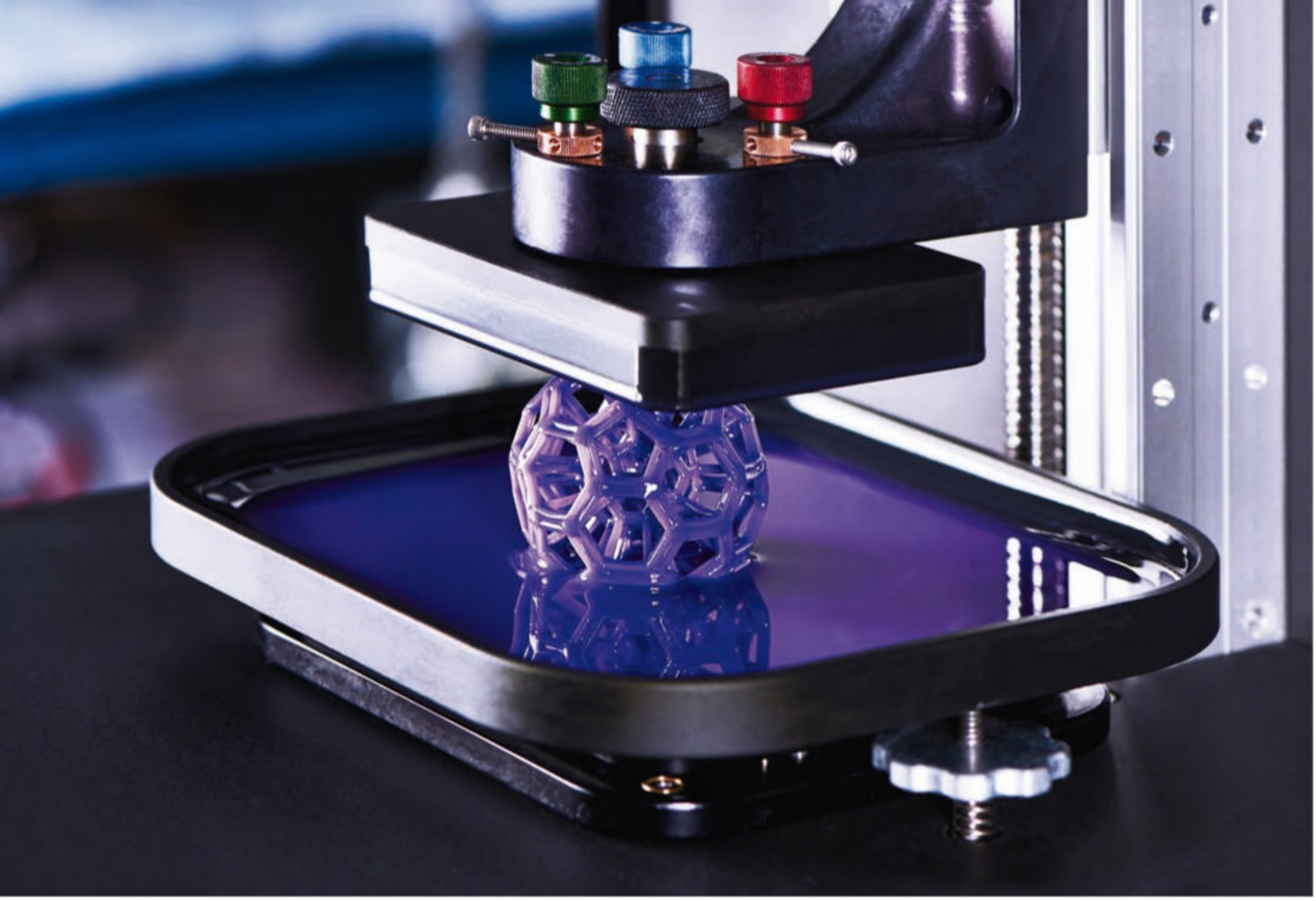


3-D PRINTING EMERGES FROM A PLASTIC SOUP

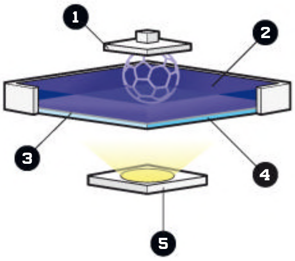
It might be the future of manufacturing, but 3-D printing is built on a 2-D foundation: A MakerBot is essentially an inkjet printer that spits out plastic instead of ink. Keep printing in the same spot over and over and the layers will form a 3-D object from the bottom up. But an outfit called Carbon3D is taking the opposite tack. Its new rig creates objects from the top down, in one continuous motion. It's faster, with no layering required.

Inspired by the mercurial T-1000 bot from *Terminator 2*, University of North Carolina prof Joseph DeSimone wanted to make objects emerge from liquid.

The process, which is based on a 30-year-old technology called stereolithography, starts with a bath of liquid resin that hardens when exposed to UV light. A projector under the bath delivers targeted blasts of UV to shape the form from below as the overhead platform lifts, drawing the object out of the soup. (The glass between the projector and the resin is permeable to oxygen, like a contact lens, and that O_2 keeps the resin from hardening too soon, before the object is complete.) The Carbon3D can print up to 100 times faster than leading 3-D and stereolithographic printers.

The startup has prototypes running at auto behemoth Ford, at an athletic apparel company, and at an f/x house, with an eye to hitting the market in 2016. But it has no phase-shifting bots that are hell-bent on destroying us. Yet.

—LEXI PANDELL



▲

Carbon3D Printer

1. Object-building platform
2. UV-curable liquid resin
3. Microthin layer of oxygenated resin
4. Oxygen-permeable glass
5. Ultraviolet-light projector

ILLUSTRATION BY BROWN BIRD DESIGN

SPENCER LOWELL

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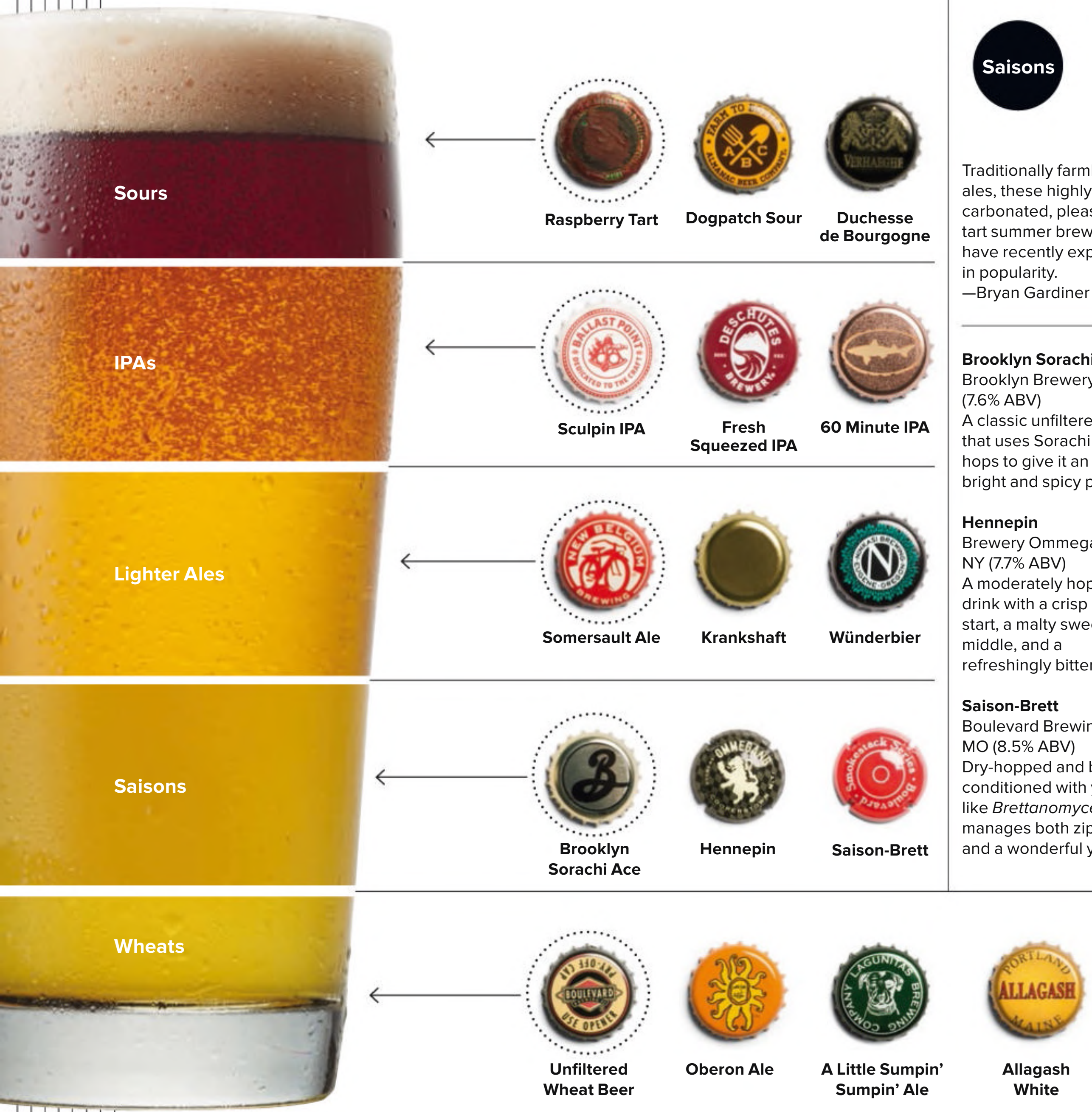
THE GUIDE

SUMMER BEER

AS THE CRAFT BREWING industry continues to grow, it continues to get weirder—in the best way possible. Beer is better than it's ever been, thanks to experimental hops, funky yeast strains, and a spirit of hackerlike ingenuity. It's not just craft, it's science.



Saisons

Traditionally farmhouse ales, these highly carbonated, pleasantly tart summer brews have recently exploded in popularity.
—Bryan Gardiner

Brooklyn Sorachi Ace
Brooklyn Brewery, NY (7.6% ABV)
A classic unfiltered saison that uses Sorachi Ace hops to give it an extra-bright and spicy punch.

Hennepin
Brewery Ommegang, NY (7.7% ABV)
A moderately hoppy drink with a crisp start, a malty sweet middle, and a refreshingly bitter finish.

Saison-Brett
Boulevard Brewing Company, MO (8.5% ABV)
Dry-hopped and bottle-conditioned with yeasts like *Brettanomyces*, this saison manages both zippiness and a wonderful yeasty stank.

ILLUSTRATIONS BY KYLE HILTON

TODD TANKERSLEY (BEER), CHRISTIE HEMM KLOK (CAPS)

IPAs

These American versions of India pale ale no longer need to be super-alcoholic for sea voyages—so their big hops are used for flavor, not camouflage. —B.G.

Sculpin IPA
Ballast Point Brewing Company, CA (7% ABV)
Lighter body helps bring out hop flavors like apricot, peach, mango, and lemon. (There are grapefruit- and habanero-forward varieties as well—both as delicious as they sound.)

Fresh Squeezed IPA
Deschutes Brewery, OR (6.4% ABV)
Despite the name, there's no fruit, but plenty of Citra and Mosaic hops give this IPA its super-citrusy flavor profile.

60 Minute IPA
Dogfish Head Brewery, DE (6% ABV)
The innovative boiling process for this eminently drinkable East Coast IPA involves fresh hops being added 60 times over an hour, which imparts plenty of citrus, cedar, pine, orange, and grassy flavors.

Sours

Rooted in Belgian styles like lambics and gueuzes, these acidic, bacteria- and yeast-enhanced beers have exploded in the States. —K. M. McFarland

Raspberry Tart
New Glarus Brewing Company, WI
(4% approx. ABV)
This Midwestern favorite brews its fair share of sours, but none like this berry-packed delight that goes down like a superfruit champagne—seriously, drink it from a flute if you can.

Dogpatch Sour
Almanac Beer Company, CA (7.5% ABV)
A little boozier than most sours, this Bay Area brew uses California cherries and the bacterium in San Francisco sourdough starter *Lactobacillus sanfranciscensis*.

Duchesse de Bourgogne
Brouwerij Verhaeghe, Belgium (6.2% ABV)
This is the perfect starter to see if you have a palate for the style—on the sweet side but with the distinct vinegar scent and tartness common to any worthy sour.

Wheats

Light and often fruity, wheat beers are refreshing but still flavorful, thanks to prodigious carbonation. Great even for non–beer lovers. —Megan Logan

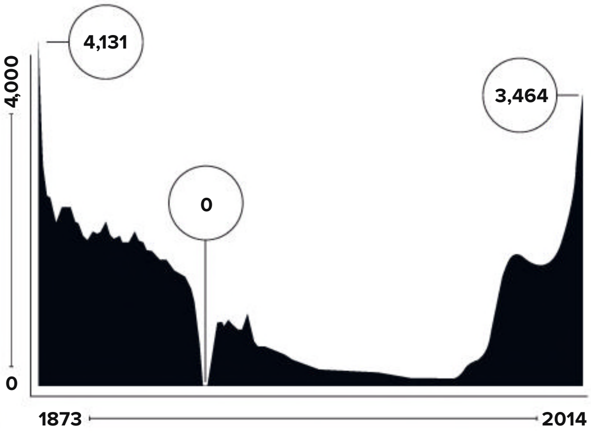
Unfiltered Wheat Beer
Boulevard Brewing Company, MO (4.4% ABV)
This cloudy, straw-colored Midwestern standby is perfectly balanced: easy-drinking citrus tempered by a tinge of hoppy bite.

Oberon Ale
Bell's Brewery, Inc., MI (5.8% ABV)
Mild hops and light malt make it a great tool for the hard work of relaxing—no wonder it's a summer staple for Michiganders.

A Little Sumpin' Sumpin' Ale
Lagunitas Brewing Company, CA (7.5% ABV)
Surprisingly potent and unapologetically hoppy—at 65 IBU (international bitterness units), it's smack in IPA range—it's not for beginners.

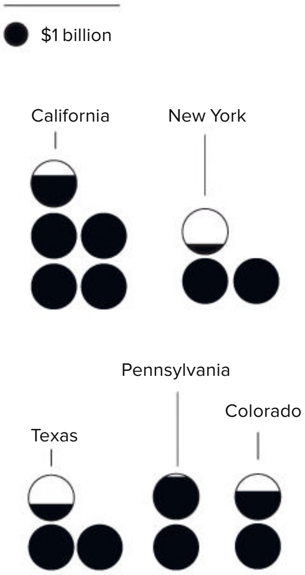
Allagash White
Allagash Brewing Company, ME (5.0% ABV)
A New England hat tip to the Belgian witbier style takes its light, spicy flavor from orange peel and coriander.

Number of breweries in the US



DATA CREDIT: BREWERS ASSOCIATION

Top 5 states, by size of brewing industry



Lighter Ales

Blonde, summer, Kölsch—there are lots of varieties of lighter ales, but all are perfect for the warmer months. —M.L.

Somersault Ale
New Belgium Brewing, CO (5.2% ABV)
Light and tangy citrus notes complement juicy peach and apricot flavors in this once-in-a-harvest-moon summer seasonal.

Krankshaft
Metropolitan Brewing, IL (5.0% ABV)
The most popular beer from the leader of Chicago's new school—a light, lemony ale that's easygoing enough for you to enjoy a few.

Wünderbier
Ninkasi Brewing Company, OR (4.4% ABV)
Fermented at higher temperatures like an ale but finished cooler like a lager, this one is only around through August, so act fast.

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ELECTRIC WORD

THE BEAUTIFUL DIVERSITY OF AUTISM

THE INTERVIEW

A conversation with *NeuroTribes*
author Steve Silberman

BY CARL ZIMMER

THE CENTERS FOR DISEASE CONTROL and Prevention estimates that one in 68 children in the US are on the autism spectrum, a number that stands in staggering contrast to a 1970 study that put the figure at one in 14,200. Some people believe we're in the middle of an autism epidemic. But autism has always been part of the human experience, as journalist (and WIRED contributor) Steve Silberman shows in his new book, *NeuroTribes: The Legacy of Autism and the Future of Neurodiversity*. It's only recently, he argues, that we have become properly aware of it. We spoke to Silberman about how the modern world came to recognize autistic people and how autistic people helped shape the modern world.

WIRED: In your book you write about Austrian pediatrician Hans Asperger, who did early work on autism in the 1930s. Why is he so important?

SILBERMAN: The more that I discovered about Asperger's conception of autism, the more it struck me as incredibly prescient. He saw autistic people as a subset of humanity that had accelerated the evolution of science and technology. They were a hidden thread in the weave of culture. They had always been here. Asperger conceived of autism as a condition that lasted from birth to death. It was not just a childhood disorder.

And yet he didn't get credit for discovering autism. This guy Leo Kanner, who wrote a paper that came out in 1943 in English, got nearly all the credit for discovering it, and Asperger was reduced to a footnote.

How did Kanner's and Asperger's concepts of autism differ?

Kanner's conception of autism was much more limited—he saw it as a rare form of childhood psychosis. Eventually, by 1948, he had decided it was caused by bad parenting—refrigerator mothers.

That had huge effects on the history of autism. Autistic children were dumped in state institutions. They did very badly, and that became what people thought was the natural course of autism. Being diagnosed with autism was considered a fate worse than death. Autistic people became invisible—not only because the kids were in institutions but also because the parents were being blamed for having caused the disorder.

So Kanner's rigid definition of autism helped create the impression it was extremely rare?

Yes. And it became a self-fulfilling prophecy: Kanner once bragged he turned away from his office nine out of 10 children who were referred to him as autistic by other clinicians, without giving them an autism diagnosis. Now you have a whole infrastructure of clinicians who are qualified to diagnose autism. Teachers know what to look for. Parents know what to look for. Everybody's looking at young children to see if they're autistic or not. Whereas back then, all you had was Leo Kanner's office.

So how did the rediscovery of Hans Asperger—and the naming of Asperger's syndrome in his honor—come about?

In the 1970s, a cognitive psychologist in England named Lorna Wing and her research assistant, Judith Gould, went out to do something that should have been done 30 years earlier—they looked at autism in the general population. They pounded the pavement in this London suburb called Camberwell, looking for autistic kids. Basically, they found that there was a broad and diverse and colorful range of presentations of autism and autistic traits in the kids. Kanner's definition was obviously too narrow, so they decided to throw it out.

Then Wing read one of Kanner's papers citing Asperger and said, "What is this other paper?" Her husband spoke German, so he translated for her, and she said, "This is it. This is what we're seeing in Camberwell."

Carl Zimmer (@carlzimmer) *is the author of 12 books. He wrote about gene therapy in issue 21.08.*

So what they did was quietly work with the American Psychiatric Association to change the diagnosis to reflect the broad and diverse reality of autism.

When you see that history laid out, it's no surprise that the estimates of autism rates went up in the 1990s. They now included conditions on the autism spectrum, like Asperger's wwand "Pervasive Development Disorder Not Otherwise Specified." Why did so many people mistake a change of diagnosis for an "autism epidemic"?

It was really a science communication issue. The people who knew what was going on, like Lorna Wing, were this tiny little circle of experts who were all talking to each other in scientific journals.

Once the diagnoses started going up, the really gripping stories were "Oh, there's an autism cluster in this polluted town in Massachusetts." *20/20* started claiming the town was having an autism epidemic. Once epidemiologists went into the town, they saw, well, no, there was nothing like that going on. It was likely just that more kids were getting the Pervasive Development Disorder Not Otherwise Specified diagnosis, which was still new. But once it turned out to be a more complicated situation, the networks would not retract their stories.

You write about how the iPad is just the latest in a long string of technologies that have helped autistic people connect with others—likely starting with ham radio in the early 1900s.

They could use the equipment to communicate. They didn't even have to talk—they could use Morse code. So they could socialize in a way that was comfortable for them.

The iPad turned out to be a boon, because specialized communication devices for autistic children were always incredibly expensive and inflexible. The iPad comes along and it can be that communication device.

How are autistic people using iPads?

Many autistic kids are more comfortable with icons than with language. They press an icon on the screen and the iPad will talk for them. It's an example of how you can improve the quality of people's lives by providing them with new avenues for communication.

As autistic people gain the ability to speak for themselves, many of them are calling for thinking about autism as one dimension of what they call neurodiversity. What does that term mean?

One way to understand it is to think of human operating systems. Just because a computer is not running Windows does not mean it's broken. It's doing things in different ways. Autistic people are bad at reading social signals but good at detecting flaws in visual patterns. They have a hard time coping with surprise, but they're good at pursuing a personal interest with great focus and intensity. So instead of diseases and cures and causations, we should think of autism as a different way of being that deserves respect and accommodation in society.

But what about someone who is nonverbal and is violently banging their head against a filing cabinet?

Instead of thinking of someone who can't talk as a hopeless case, neurodiversity would say, "Let's look for ways to help them communicate." It turns out many, many autistic people who are nonverbal are incredibly intelligent. But they need some technological help to articulate their thoughts.

If we're able to improve communication, we might discover that the kid is not hitting herself because she has autism. Maybe the hum of the fluorescent light is driving her crazy. Unless you strive to open a channel of communication with the kid, you'll never understand. ▣

ANGRY NERD

NO MORE SPIES LIKE US!

For once, the reason I'm shouting, "Uncle!" isn't a third-grade bully! I can't wait for the new movie adaptation of *The Man From U.N.C.L.E.*, mostly because it actually takes place in the 1960s, when the original series was set. Its Ian Fleming– created blend of gadgetry, fisticuffs, and acronymic secret societies is as '60s as it gets: frequently absurd yet always self-aware enough to be tongue-in-cheek. (That's why I never got the Austin Powers films—they're like a spoof of a spoof.) And somehow, *U.N.C.L.E.* director Guy Ritchie of all people looks to be maintaining that aesthetic! His respect for the source material is all the more surprising given that the further we get from the 1960s, the more generic spy cinema has gotten. The rebooted Jack Ryan flicks, the *Mission: Impossible* franchise, even modern-day Bond films—they're just action movies. Resituating classic characters in the present day is positively Blofeldian! That's why, inspired by *The Man From U.N.C.L.E.*, I'm founding my own evil organization. As the overlord of S.T.F.U. (Stopping Time-based Franchise Updates), I will lobby ceaselessly to ensure that Guy Ritchie is granted stewardship of any and all Cold War–era thrillers. Anyone else who dares step behind the lens will have a reservation for one at the laser-shark arena in my secret volcano lair!

ZOHAR LAZAR

Q:

I work in a casual tech setting and I'm shocked by how much everyone swears. Should I say something?

BY JON MOOALLEM

A: Imagine what it was like to be a Puritan in 1642. You've come to America. The landscape is crude and endless; the soundtrack, all hissing insects and howling wolves. "Everything about the place seemed god-forsaken," writes the natural historian Tim Flannery in his book *The Eternal Frontier*. That lawless emptiness is why you're here—it means freedom. But in all free and empty places, there's also room for wickedness to grow. Everybody in your little settlement is aware of this, which is why they panic when, one day, someone happens upon a young man named Thomas Granger having sex with a horse.

It's worse than you thought: When confronted, Granger rapidly admits he's also had intercourse with three cows, two goats, five sheep, and a turkey. This behavior is so savage—and feels like such a threat to the ethical society you're laboring to build there in the wild—that you respond with a campaign of ruthless cleansing. You round up each animal Granger has had sex with and force the young man to watch while you slaughter it. (Not the turkey, though; for some reason, Flannery notes, no one bothers with the turkey.) And since you can't tell which of the village's sheep were the particular sheep Granger penetrated—his descriptions are imprecise—you herd every sheep in front of him, like a police lineup, and force him to ID the five in question. Then you kill those five sheep too. Then you kill Granger. Then you throw all their bodies together in one big pit.

Now, fast-forward 373 years. Let's talk about you.

It's easy to imagine you, hunched in your tech company's open floor plan, forced to sit on an inflatable ball or perhaps issued one of those iconoclastic standing desks without a chair at all. You are a wary pilgrim on the wild, godless edge of America's economic frontier. And, as such, you understand that the foul language your colleagues are using isn't just unpleasant but morally precarious; if it continues unchecked, it could lead you all—your entire industry, really—to much darker places. You know, just as the Puritans did, that this kind of impropriety needs to be nipped in the bud.

CHRISTOPH NIEMANN

That's how you feel, right? Well, you're wrong.

You're not the Puritans. You're the kid shtupping the cows. Because the lesson of the Granger story—as I read it—isn't that morality always wins. It's that the mob always wins. The majority's norms always beat back and outlast the minority's. And the mob can be cruel: They'll kill the thing you love right in front of you, then dump you in the ground.

I think you need to go along with the mob.

Q:

Does it matter if my kid's handwriting is terrible?

A: Well, I happen to love handwriting. I think it's curiously fun to look at and a considerable, if mostly esoteric, value-add to the written language—even in an era of tablets and smartwatches and speech-recognition software. But does it matter if your child writes illegibly? My answer is no, probably not. Handwriting is an old technology—about 5,000 years old. And as with newer old technologies (muskets or floppy disks or cars with human beings driving them), some people may inevitably feel a tinge of melancholy watching it sputter into oblivion. And yet the truth is that humanity has always replaced old tools with new ones, and often, once we've pushed through the emotionally charged transitional phase and come out the other end, everything feels fine again.

Take, for example, a woman named Kristin Gulick in Bend, Oregon, who often has trouble reading messages scribbled by her chronically illegible office receptionist. "Yesterday I tried to dial a number that she'd written down, and I couldn't read it," Gulick told me recently. "I had to go back out and ask, 'What does this say?'" And the receptionist was just like, ha ha ha, I know my handwriting's terrible—you know, giggling the annoyance away. Was Gulick peeved? Yes. But was this a fireable offense or some irrevocable inconvenience? Not even close. In fact, Gulick really had no choice but to laugh the whole thing off too. "Thank God she's good at other things!" she said, and life went on.

So there's your answer. But who is Kristin Gulick, anyway? So glad you asked!

Gulick has been an occupational therapist for 28 years, specializing in arms and hands. She's in private practice now, but shortly after 9/11 she found herself working at Walter Reed Army Medical Center in Washington, DC. A recent government report disclosed that more than 1,000 of the 50,000 soldiers who've been wounded in action in Iraq and Afghanistan—2.6 percent—have come back missing limbs, and Gulick was there to greet some of the first ones, helping them work around their loss and rejoin their life. Part of this work involved "transferring dominance" from one hand to the other; if a righty lost their right arm, say, they needed to learn to be a lefty now. And part of that was relearning handwriting—even just enough to fill out the deluge of hospital forms and sign their name. Gulick found a total dearth of tools and curricula. Really, there was nothing. While she encouraged people to use first-grade handwriting primers early in her career, they were full of infantilizing penmanship exercises involving anthropomorphic animals. These books were not only unhelpful but degrading: Having lost a limb, many of these people were already feeling vulnerable and diminished. Now they were being treated—literally—like children. Gulick and an officer in the Army Medical Specialist Corps, Katie Yancosek, decided they could do better. "We'd give them exercises about balancing your checkbook and not about a little bunny or whatever," Gulick said. The result was a six-week program, laid out in a workbook called *Handwriting for Heroes*. (The third edition was published this year.)

Look, I don't mean to play some righteous, wounded-veteran card and make anyone feel bad. But I think we all see where this is going: It's easy to write off handwriting only because most of us take it for granted. But I listened to Gulick talk about handwriting for a while, about what the ability to jot off a simple grocery list or be-right-back note for your spouse—functional but maybe also aesthetically pleasing or expressive, something you have created—does for a person's sense of self-sufficiency and pride after working hard to regain that skill. How handwriting, really, may be one of those fundamentally human abilities—one that binds us, in a tiny way, to each other and to our own identities.

Handwriting may be one of those fundamentally human abilities—one that binds us to our own identities.

Your child won't feel anything remotely like that sense of loss if they let their handwriting go to seed. Their lives will move forward in standardized fonts. If they absolutely have to write anything by hand, it may be disordered and illegible, but they can just laugh it off and explain (or text) what they meant. And that's why I'll stick with my first answer: It probably doesn't matter. But I also think that, if we're prepared to let handwriting go—to not care how ugly it gets—we should, at least, take a second to think about how beautiful it can be.

Speak and Spell
How dictation software makes us rethink writing.

BY CLIVE THOMPSON

IF I'VE WRITTEN YOU an email on my phone lately, you might have noticed something slightly off about it. It doesn't read like email from me used to. I use fewer contractions, fewer adverbs, and I'm more likely to ramble. ¶ What's changed is that, a year ago, I discovered that Android and Apple phones have become so good at transcription, it's now much faster for me to talk than type. (And that's saying a lot: I was a fast phone-typist.) So while sending texts and emails or using chat apps on my phone, I started talking it out—then quickly cleaning up any wrong words. There are shockingly few. I'd estimate that fully two-thirds of all messages I compose on my phone are now spoken. ¶ I'm probably an extreme case—but only for now. People are rapidly adopting voice-writing. Nuance, a leading firm running cloud-transcription services for mobile devices, processes 48 percent more voice than it did a year ago, with an average accuracy of 95 percent. ¶ That's convenient and futuristic-sounding. But it's also going to change the way we write. For one, it may make our prose more casual. One small study of correspondence between two academics in 2003 found that when one of them shifted to voice-dictation software, his sentences became a bit shorter, he used status markers like "sir" and "boss" less often, and he was more likely to use first-person pronouns. "People are more personal when they're speaking," says James Pennebaker, a social psychologist who coauthored the research.

This would continue the grand trend of digital communication: making our prose more colloquial, as Naomi Baron, a linguist at American University, has found in studying online language. One friend of mine, the designer Natalie Roth, has indeed noticed that dictation makes her sound like a slightly less complex thinker: "I simplify what I'm saying so the computer will understand it. It's the way I speak to someone when I know that their English is a bit rusty."

Then again, it's certainly *possible* to be formal and stylized, if you try. Late in his career, Henry James shifted from typing his novels to dictating them, and his prose actually became more ornate in the process, not less. ("He luxuriated in fine phrases and he was exquisitely baroque," his biographer Leon Edel told *The Paris Review*.)

But voice-writing isn't just about the quality of our prose. It's a social shift, because you're saying out loud something that was previously hidden and private. A crowded bus may not be the best time to dictate an email about your weird new rash. On the other hand, my wife and I don't mind occasionally hearing the other's email, so we dictate when we're home, giving us a curious (and often hilarious) awareness of one another's correspondence. I've developed a mental habit when I'm out in public: quickly assessing which texts should remain typed.

In a sense, voice-writing requires people to change their cognitive style. It's relatively free and easy, more like speech than writing. But because it's hard to edit and tinker, dictating to a phone is most like working on an old manual typewriter, where you have to map out each sentence in your head before clacking away. "I think through more completely what I'm trying to say," Erik Olsen, a video journalist at *The New York Times* and another dictation adherent, told me.

So consider this a possible gift from a new technology. We live in a world of explosive publishing, where people compose far more prose than ever before. It'd be nice if a tool finally encouraged us to think before we speak.

ZOHAR LAZAR

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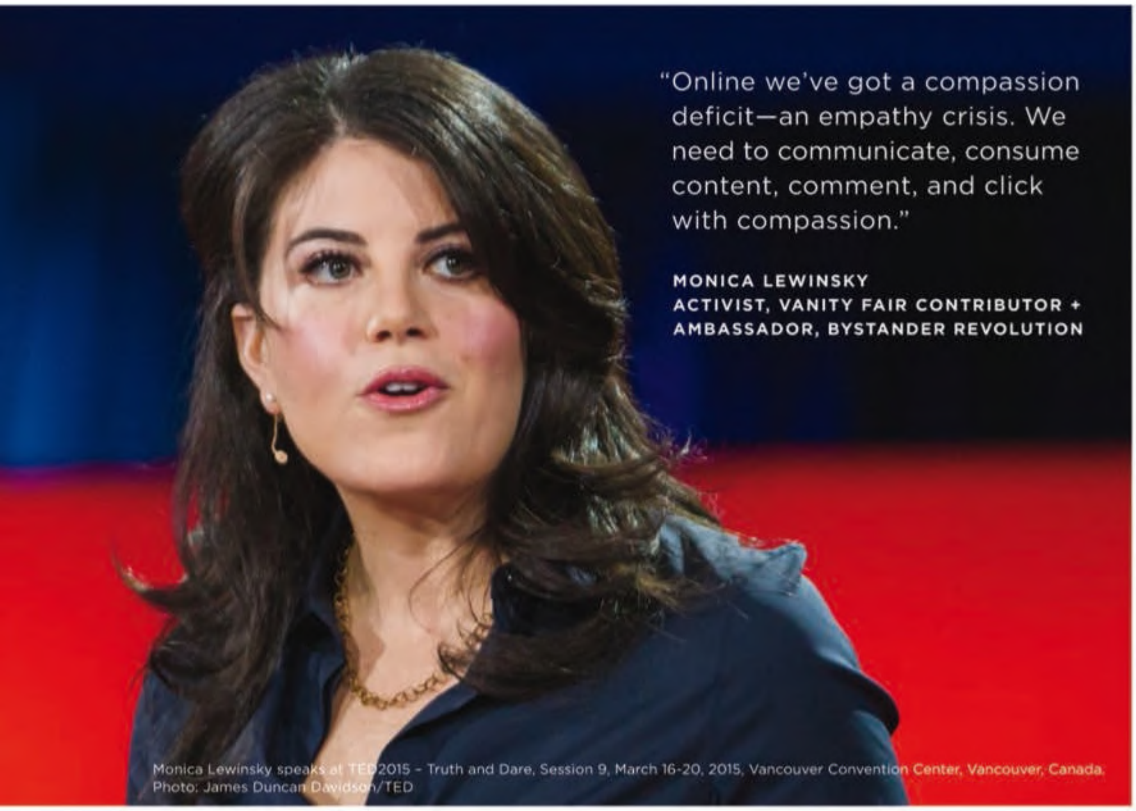

"Online we've got a compassion deficit—an empathy crisis. We need to communicate, consume content, comment, and click with compassion."

MONICA LEWINSKY
ACTIVIST, VANITY FAIR CONTRIBUTOR +
AMBASSADOR, BYSTANDER REVOLUTION

Monica Lewinsky speaks at TED2015 - Truth and Dare, Session 9, March 16-20, 2015, Vancouver Convention Center, Vancouver, Canada.
Photo: James Duncan Davidson/TED

"One of the most powerful and challenging crossroads is where tech and humanity meet—and sometimes collide," says Monica Lewinsky. "While the Internet has made us a more globally connected society, it can also disconnect us from humanity—our own and seeing it in others. That is the crux of the pandemic we face with cyberbullying and online harassment." Lewinsky boldly wants to take back the very Internet that once turned on her in possibly the first example of online bullying—and leverage its intrinsic power to help solve the problem. She highlights Bystander Revolution, an online platform whose mission is to inspire individuals to take the bite out of bullying with simple acts of kindness, courage, and inclusion. www.bystanderrevolution.org

We know you're excited about technology, maybe you're worried.
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Is technology making us less empathetic?

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ROCK OUT

ARP ODYSSEY

FETISH

REBIRTH OF COOL

THE ORIGINAL ARP Odyssey synthesizer debuted in 1972 and defined the sound of the era, adding mystical swooshes and bright passages to the funk of Herbie Hancock, the futurepop of Kraftwerk, and countless horror film scores. Though the all-analog Odyssey was widely praised, production stopped in 1981 when ARP folded due to cash flow problems. Working units grew increasingly rare until this year, when Korg, another legendary synth maker, resurrected it. The modular tone circuits in this reboot are faithful analog re-creations of the originals, but there are some 21st-century enhancements too: The original came in three versions, each with a different tone-coloring filter; the new model incorporates all three filters into one unit. The neo-Odyssey is also more compact and better suited to modern stages and studios, where the next generation of analog enthusiasts will surely coax their own astral textures out of this time-hopping sound machine. —**MICHAEL CALORE**

$999

Odyssey Highlights

Herbie Hancock
"Chameleon"

Nine Inch Nails
"The Hand
That Feeds"

Rush
"2112: Overture"

PROP STYLING BY JAMES WHITNEY / ARTIST UNTIED: SAND ART BY KIRK RADEMAKER / SANDGUYS.COM

MOLLY CRANNA

GEARHEAD WAXWORKS

You don't need skinny jeans and elaborate facial hair to appreciate vinyl. But if you want your LPs to impress, cue up this gear. —BRYAN GARDINER

1

Pro-Ject RPM 1 Carbon Turntable

A cool Benjamin can get you something that'll spin your records at 33⅓ rpm, but why cheap out on a key part of your stack? The stylish RPM 1 Carbon gives you audiophile-grade features like a rumble-resistant platter and a vibration-damping tone arm for a decidedly non-audiophile price.

$499

2

RCA Discwasher Vinyl Record Care System

LPs are delicate—dust, fingerprints, and other gunk can ruin the aural atmosphere and decimate the lifespan of your stylus. This brush-and-cleaning-solution set will eliminate snaps, crackles, and pops, keeping all your wax in the spin cycle.

$15

MOLLY CRANNA

3

GoldenEar Triton Seven

The audiophile world is rife with specious claims, but here's an immutable truth: Bigger speakers sound better. These 40-inch towers, each equipped with two main drivers, a ribbon tweeter, and dual sub-bass boomers, deliver amazing clarity and a sumptuous soundstage.

$1,398/pair

4

Schiit Mani Phono Preamp

You can't plug a turntable straight into a modern amplifier—signal boosting is required, and that's where the Mani excels. This low-noise preamp works with both moving-magnet and moving-coil phono cartridges to reveal all the groovy details with no distortion.

$129

5

Peachtree Audio nova220SE

Capable of outputting 350 watts per channel, this do-it-all integrated amp has the power to drive just about any speaker. The wood-sheathed beauty also comes with a built-in headphone amp for when your partner refuses to listen to *Physical Graffiti* one ... more ... time.

$1,599

ROCK OUT

BLUETOOTH STEREOS

HEAD-TO-HEAD AIR SUPPLIES

The jams don't have to stay in your pocket. Set your music loose with one of these wireless systems. —BRYAN GARDINER

Audioengine B2

BEST FOR: People who think Bluetooth can't sound amazing

Powered by a 60-watt amp and sheathed in your choice of walnut, zebrawood, or black ash, the Audioengine B2 is as muscular as it is handsome. A built-in 24-bit digital-to-analog converter and support for the high-quality Bluetooth aptX codec ensure that your streaming files sound their absolute best.

$299

Griffin Twenty

BEST FOR: Old-school audiophiles with vintage speakers

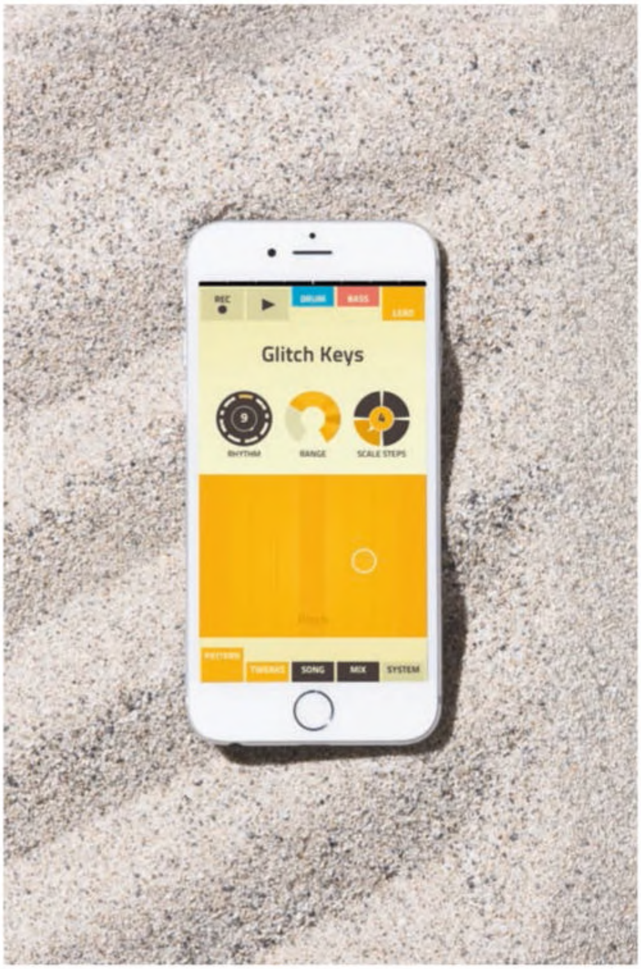
Like the B2, the Griffin Twenty supports aptX audio streaming. Unlike with the B2, you'll need to bring your own speakers to this party. The super-efficient 20-watt amp lets you hook up those passive loudspeakers stashed in your attic and recast them as a wicked wireless system. A digital input lets you hook up your Xbox or HDTV too.

$150

MOLLY CRANNA

APP PACK
BEATS TO GO

Use your phone for more than just listening to tunes. With the right tools, you can be an artist too. —MICHAEL CALORE



NOISEMAKERS

Animoog

The synth pioneers at Moog give the signature sound of their analog keyboards the digital treatment with this stellar app. Its infinitely customizable controls will impress pros, and its expressive playability will delight even non-musicians. **$6 (iOS)**

Caustic 3

Combine 14 synths and 16 audio effects to create funky keyboard sounds and sparkling melodies. The knobs, sliders, blinking lights, and virtual patch cables impart a note of skeuomorphic charm. **$10 (ANDROID, iOS)**

SONG BUILDERS

Yellofier

This app records snippets of noise—a piano chord, a hand clap, a cat's meow—and plops them into colorful onscreen blocks. Arrange the blocks to make a beat, a melody, or an entire song. **$3 (ANDROID, iOS)**

Figure (shown right)

Start by picking an instrument—myriad drum, bass, and "lead" sounds are offered—then tap to play. Build a song in layers, overdubbing each part. It's virulently addictive and, since it fixes flubs on the fly, incredibly forgiving. **FREE (iOS)**

RECORDERS

FourTrack

This multitrack recorder captures your inspired moments in CD quality. Lay down instrumental parts, sing on top, then mix and EQ the results. There's even a guitar-amp emulator for that epic solo after the bridge. **$5 (iOS)**

Audio Evolution Mobile Studio

Use this porta-studio to record live instruments, add effects like chorus or delay, and mix the results. Cut, paste, and crossfade to build loops or delete boring parts. In-app purchases unlock more tricks. **$7 (ANDROID)**

PUBLISHERS

SoundCloud

Your newest jam is a bombtrack. Share it with the community of songwriters and DJs on SoundCloud. Browse and befriend like-minded creators inside the app, and encourage them to stream your songs. **FREE (ANDROID, iOS)**

Bandcamp

Pressing your debut chillwave EP to vinyl is cost-prohibitive; upload it to Bandcamp instead. The app lets you discover and follow similar artists and build your brand. Fans can follow you with one tap. **FREE WITH SONG PURCHASE (ANDROID, iOS)**

BENCHMARK
HIT RECORD

It's a digital world, but that song you're streaming sounds better if it was originally encoded in iron oxide. —VICTOR KRUMMENACHER

LOVE ISN'T ALWAYS RATIONAL. Witness magnetic tape. The analog technology, which uses a coating of iron oxide powder on a thin strip of plastic film to capture and store live audio, was commercially developed by the German company BASF in the 1930s. It was ubiquitous in recording studios until digital technology relegated it to boutique status a quarter century ago. Hissy, fussy tape is no match for a computer's crystal clarity, but purists like D'Angelo and storied producer-performer Steve Albini (Big Black, Shellac) still swear by their reel-to-reel recorders. Those analog preamps running sound onto tape afford a natural compression that delivers a warmer sound. Also, tape reels can survive decades if properly stored—try retrieving a Pro Tools mix from 2004 and see if all your plug-ins from that era still load. That an 80-year-old technology is still the format of choice for many of today's recordings is testimony to our love, irrational as it may be.

$30–50 per reel

Master reel for **Camper Van Beethoven**'s album *Our Beloved Revolutionary Sweetheart.* Krummenacher is a founding member of the band.

▼

Tape Recordings

D'Angelo
"The Charade"

Foo Fighters
"Something From Nothing"

Shellac
"Compliant"

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ROCK OUT

JOE BROWN

SONGS IN THE KEY OF FAMILIAR

Streaming music services give us tracks we like. But we need tracks we'll love.

Back when 15 bucks was a lot of money to me, I bought Led Zeppelin's debut album after listening to it on in-store headphones at HMV—every day for a week. The first play, though, is one of my most powerful musical memories: I felt those first two chords roll into my head and watched my arm raise up, hand in an autonomic rock-fingers salute. When I finally brought the CD home, I was so excited that I broke the jewel box trying to breach the security sticker. ¶ By college—aka the Napster era—I was no longer shelling out for music; but if time is money, I was still paying. I'd hear a song and get curious about the artist. Then I'd steal some tracks. A song could take an hour to download, and storage was far from free. So to ensure I didn't waste time or space, I'd do research to see if the band was worth it: cruise a BBS, talk to friends. I'd listen to it several times. If a song was good, I'd burn it to minidisc. (Yep, I'm that guy.) Bad tracks got trashed. My mixes were amazing. The process was full of what technologists call friction, the supposed enemy of a good user experience. Yet those college-era mixes remain among my favorites. ¶ Friction or no, that music I worked so hard for has more staying power than the crap I'm playing now. In pathetic midthirties-guy fashion, I try to stay relevant. I subscribe to Spotify's curated new-music playlists and delve into the app's Discover tab. When I find something I like, I add it to a playlist. But here's the problem: Even though I like a song when I add it, I'm soon tired of every track in that queue. Is modern music that bad? Is it just me? I wonder what a neuroscientist would say ...

"When you hear music that you find intensely pleasurable, it triggers a dopamine response," says Valorie Salimpoor, a neuroscientist at the Rotman Research Institute who monitored the brain activity of test subjects as they listened to music. That dopaminergic response explains why people like me crave music. But how does our brain decide what's good?

Turns out, subjects "also showed activity in the superior temporal cortex." That's where the brain stores sound. Salimpoor thinks the brain privileges music that's like stuff you've heard before. Music services take advantage of this. "It's how discovery engines work," she says. Streaming services recommend songs with sonic signatures similar to those of your top tracks.

But there's a flaw in this—and it may explain my shitty playlists. "Dopamine responses are optimized by an element of uncertainty," Salimpoor says. "Remember the feeling before a first date when you were a teen? You had a template in your mind of how it could go—maybe very well—but there was also uncertainty, and you felt a rush of anticipation." This is how our brains train us to pursue pleasure—and to try new things. It's also why those recommendation engines *should* work. But the songs don't always hold up their end.

Pop music is so engineered to hit your dopamine jets that it won't sustain the rush. When the music is so predictably similar, "the dopamine response will quickly diminish. It's why people love improvisational music like jazz—it's different every time." So that Discover tab? It's just giving me a short-term high, then I'm crashing hard.

A better drug—or recommendation algorithm—would be one that builds on what I like while challenging me to branch out more. In the meantime, know any good jazz?

Email joe@WIRED.com.

TAVIS COBURN

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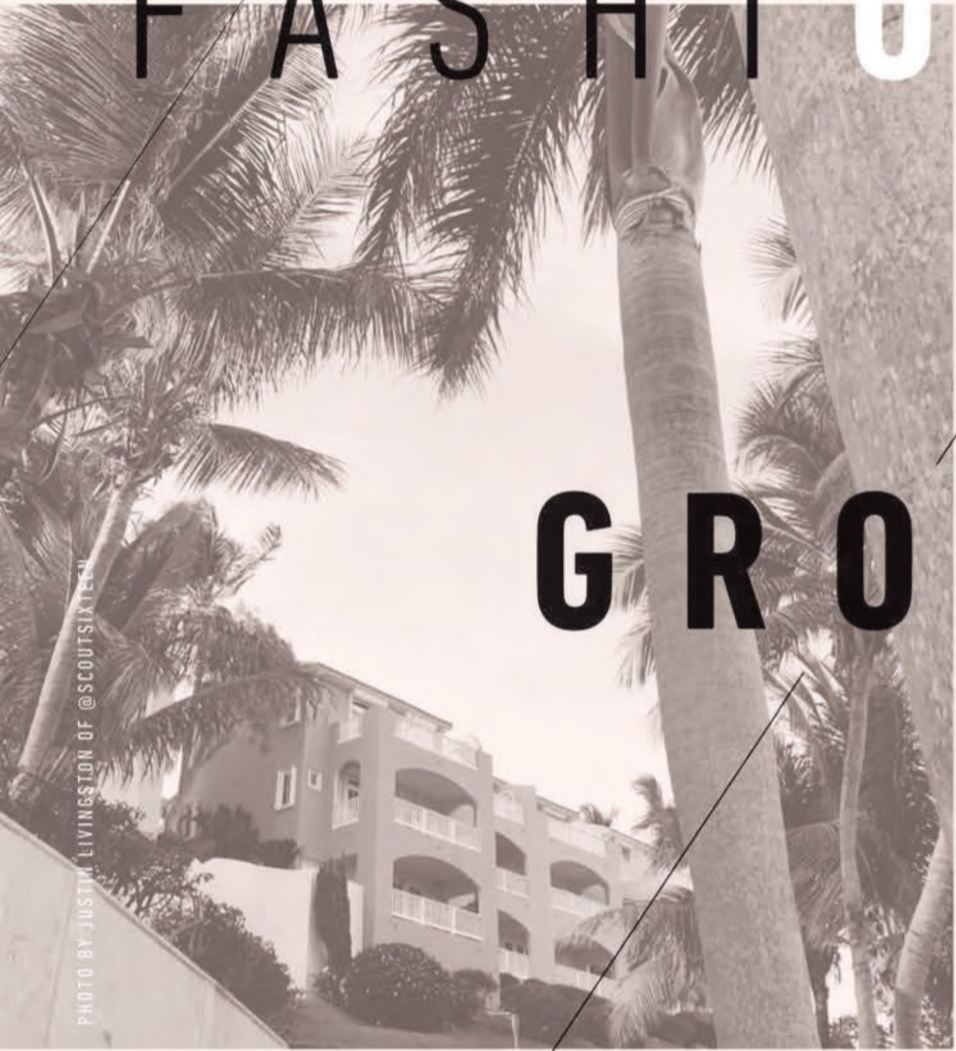
FASHION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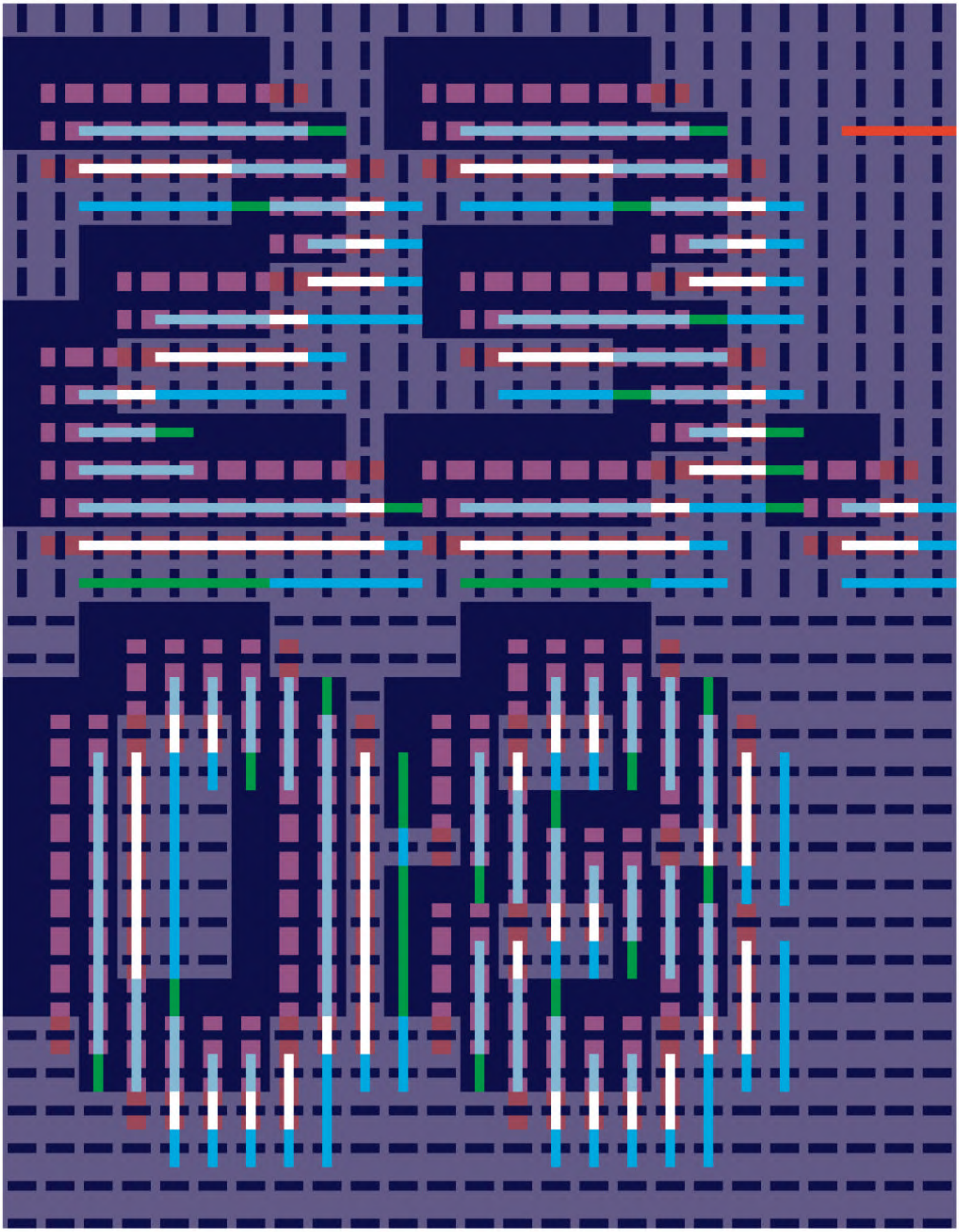

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MUIR MCNEIL

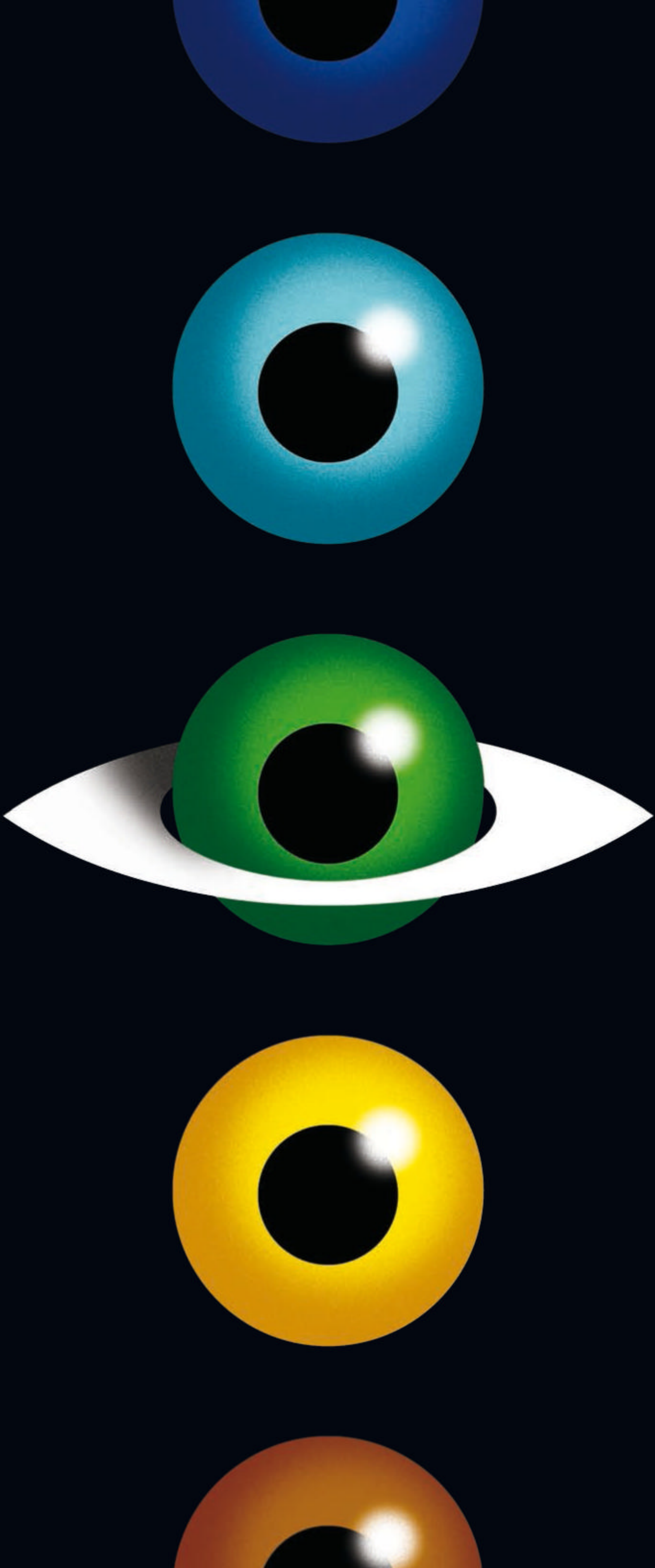
The Genesis Engine.

We now have the power to quickly and easily alter DNA. It could eliminate disease. It could solve world hunger. It could provide unlimited clean energy.

It could really get out of hand.

by Amy Maxmen

Ben Wiseman



Spiny grass and scraggly pines creep amid the arts-and-crafts buildings of the Asilomar Conference Grounds, 100 acres of dune where California's Monterey Peninsula hammerheads into the Pacific. It's a rugged landscape, designed to inspire people to contemplate their evolving place on Earth. So it was natural that 140 scientists gathered here in 1975 for an unprecedented conference.

They were worried about what people called "recombinant DNA," the manipulation of the source code of life. It had been just 22 years since James Watson, Francis Crick, and Rosalind Franklin described what DNA was—deoxyribonucleic acid, four different structures called bases stuck to a backbone of sugar and phosphate, in sequences thousands of bases long. DNA is what genes are made of, and genes are the basis of heredity.

Preeminent genetic researchers like David Baltimore, then at MIT, went to Asilomar to grapple with the implications of being able to decrypt and reorder genes. It was a God-like power—to plug genes from one living thing into another. Used wisely, it had the potential to save millions of lives. But the scientists also knew their creations might slip out of their control. They wanted to consider what ought to be off-limits.

By 1975, other fields of science—like physics—were subject to broad restrictions. Hardly anyone was allowed to work on atomic bombs, say. But biology was different. Biologists still let the winding road of research guide their steps. On occasion, regulatory bodies had acted retrospectively—after Nuremberg, Tuskegee, and the human radiation experiments, external enforcement entities had told biologists they weren't allowed to do that bad thing *again*. Asilomar, though, was about establishing prospective guidelines, a remarkably open and forward-thinking move.

At the end of the meeting, Baltimore and four other molecular biologists stayed up all night writing a consensus statement. They laid out ways to isolate potentially dangerous experiments and determined that cloning or otherwise messing with dangerous pathogens should be off-limits. A few attendees fretted about the idea of modifications of the human "germ line"—changes that would be passed on from one generation to the next—but most thought that was so far off as to be unrealistic. Engineering microbes was hard enough. The rules the Asilomar scientists hoped biology would follow didn't look much further ahead than ideas and proposals already on their desks.

Earlier this year, Baltimore joined 17 other researchers for another California conference, this one at the Carneros Inn in Napa Valley. "It was a feeling of déjà vu," Baltimore says. There he was again, gathered with some of the smartest scientists on earth to talk about the implications of genome engineering.

The stakes, however, have changed. Everyone at the Napa meeting had access to a gene-editing technique called Crispr-Cas9. The first term is an acronym for "clustered regularly interspaced short palindromic repeats," a description of the genetic basis of the method; Cas9 is the name of a protein that makes it work. Technical details aside, Crispr-Cas9 makes it easy, cheap, and fast to move genes around—any genes, in any living thing, from bacteria to people. "These are monumental moments in the history of biomedical research," Baltimore says. "They don't happen every day."

Using the three-year-old technique, researchers have already reversed mutations that cause blindness, stopped cancer cells from multiplying, and made cells impervious to the virus that causes AIDS. Agronomists have rendered wheat invulnerable to killer fungi like powdery mildew, hinting at engineered staple crops that can feed a population of 9 billion on an ever-warmer planet. Bioengineers have used Crispr to alter the DNA of yeast so that it consumes plant matter and excretes ethanol, promising an end to reliance on petrochemicals. Startups devoted to Crispr have launched. International pharmaceutical and agricultural companies have spun up Crispr R&D. Two of the most powerful universities in the US are engaged in a vicious war over the basic patent. Depending on what kind of person you are, Crispr makes you see a gleaming world of the future, a Nobel medallion, or dollar signs.

The technique is revolutionary, and like all revolutions, it's perilous. Crispr goes well beyond anything the Asilomar conference discussed. It could at last allow genetics researchers to conjure everything anyone has ever worried they would—designer babies, invasive mutants, species-specific bioweapons, and a dozen other apocalyptic sci-fi tropes. It brings with it all-new rules for the practice of research in the life sciences. But no one knows what the rules are—or who will be the first to break them.

In a way, humans were genetic engineers long before anyone knew what a gene was. They could give living things new traits—sweeter kernels of corn, flatter bulldog faces—through selective breeding. But it took time, and it didn't always pan out. By the 1930s refining nature got faster. Scientists bombarded seeds and insect eggs with x-rays, causing mutations to scatter through genomes like shrapnel. If one of hundreds of irradiated plants or insects grew up with the traits scientists desired, they bred it and tossed the rest. That's where red grapefruits came from, and most barley for modern beer.

Genome modification has become less of a crapshoot. In 2002, molecular biologists learned to delete or replace specific genes using enzymes called zinc-finger nucleases; the next-generation technique used enzymes named TALENs.

Yet the procedures were expensive and complicated. They only worked on organisms whose molecular innards had been thoroughly dissected—like mice or fruit flies. Genome engineers went on the hunt for something better.

As it happened, the people who found it weren't genome engineers at all. They were basic researchers, trying to unravel the origin of life by sequencing the genomes of ancient bacteria and microbes called Archaea (as in archaic), descendants of the first life on Earth. Deep amid the bases, the As, Ts, Gs, and Cs that made up those DNA sequences, microbiologists noticed recurring segments that were the same back to front and front to back—palindromes. The researchers didn't know what these segments did, but they knew they were weird. In a branding exercise only scientists could love, they named these clusters of repeating palindromes Crispr.

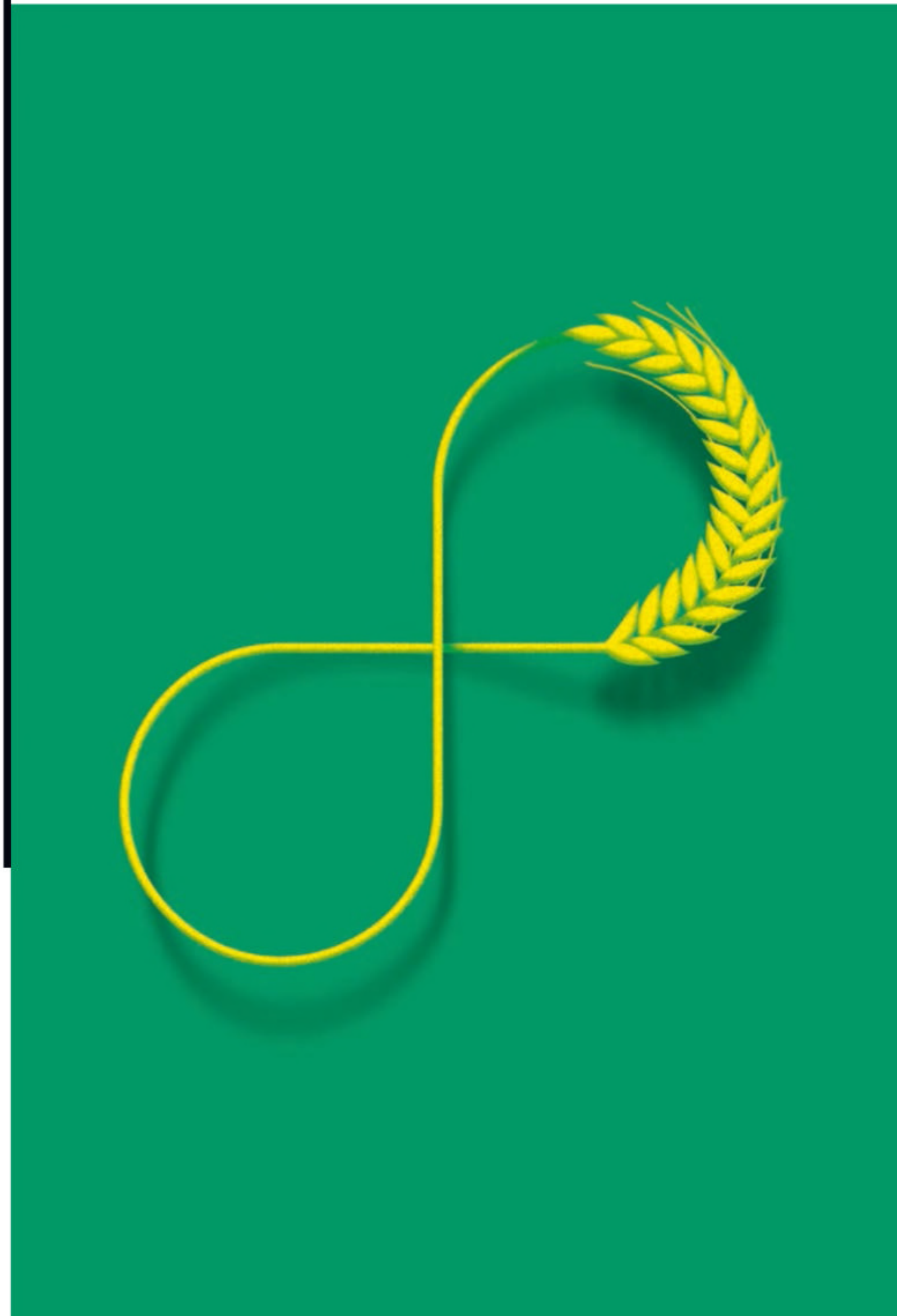
Then, in 2005, a microbiologist named Rodolphe Barrangou, working at a Danish food company called Danisco, spotted some of those same palindromic repeats in *Streptococcus thermophilus*, the bacteria that the company uses to make yogurt and cheese. Barrangou and his colleagues discovered that the unidentified stretches of DNA between Crispr's palindromes matched sequences from viruses that had infected their *S. thermophilus* colonies. Like most living things, bacteria get attacked by viruses—in this case they're called bacteriophages, or phages for short. Barrangou's team went on to show that the segments served an important role in the bacteria's defense against the phages, a sort of immunological memory. If a phage infected a microbe whose Crispr carried its fingerprint, the bacteria could recognize the phage and fight back. Barrangou and his colleagues realized they could save their company some money by selecting *S. thermophilus* species with Crispr sequences that resisted common dairy viruses.

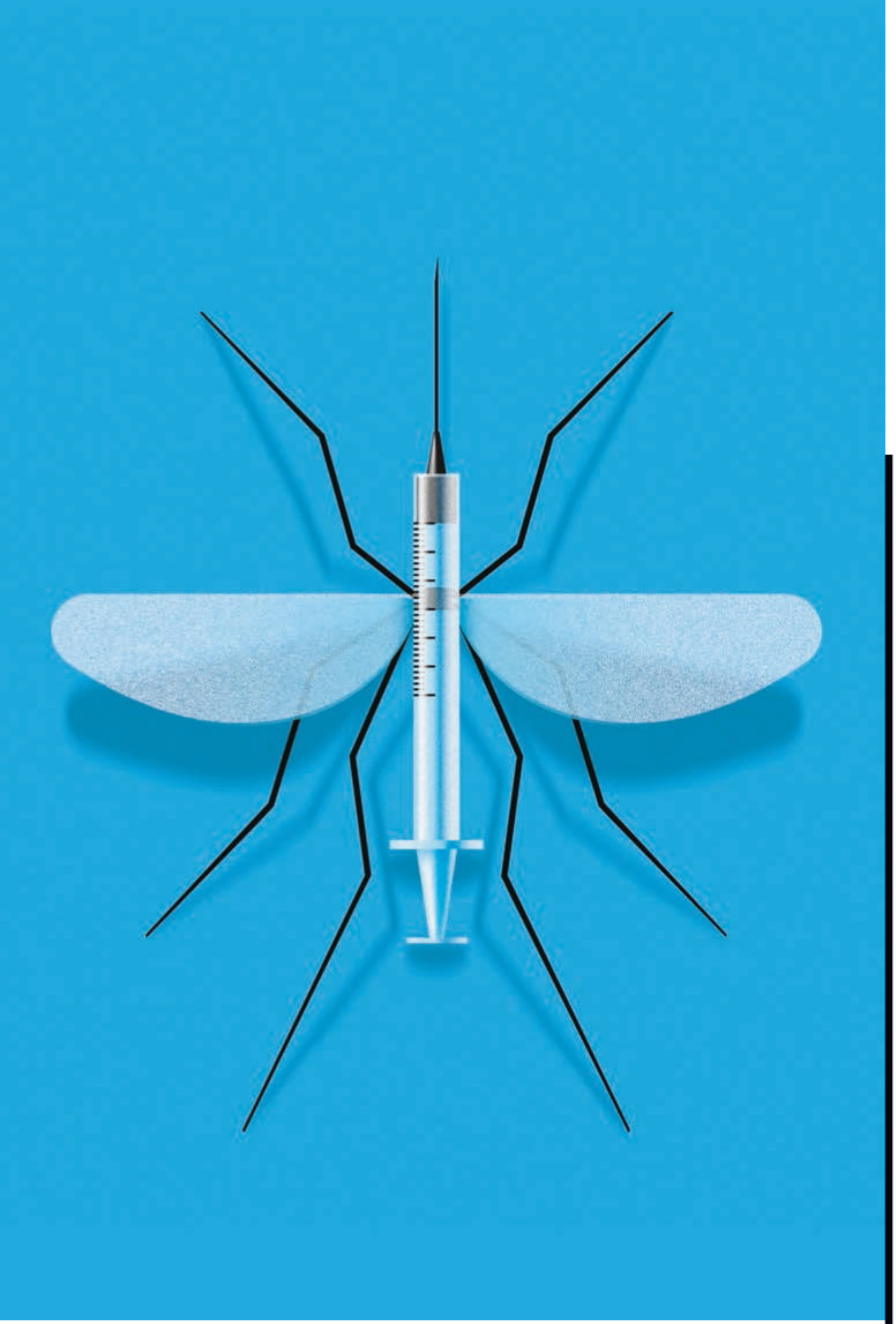
As more researchers sequenced more bacteria, they found Crisprs again and again—half of all bacteria had them. Most Archaea did too. And even stranger, some of Crispr's sequences didn't encode the eventual manufacture of a protein, as is typical of a gene, but instead led to RNA—single-stranded genetic material. (DNA, of course, is double-stranded.)

That pointed to a new hypothesis. Most present-day animals and plants defend themselves against viruses with structures made out of RNA. So a few researchers started to wonder if Crispr was a primordial immune system. Among the people working on that idea was Jill Banfield, a geomicrobiologist at UC Berkeley, who had found Crispr sequences in microbes she collected from acidic, 110-degree water from the defunct Iron Mountain Mine in Shasta County, California. But to figure out if she was right, she needed help.

Luckily, one of the country's best-known RNA experts, a biochemist named Jennifer Doudna, worked on the other side of campus in an office with a view of the Bay and San Francisco's skyline. It certainly

Scientists have used it to render wheat invulnerable to killer fungi. Such crops could feed billions of people.





If new genes that wipe out malaria also make mosquitoes go extinct, what will bats eat?

wasn't what Doudna had imagined for herself as a girl growing up on the Big Island of Hawaii. She simply liked math and chemistry—an affinity that took her to Harvard and then to a postdoc at the University of Colorado. That's where she made her initial important discoveries, revealing the three-dimensional structure of complex RNA molecules that could, like enzymes, catalyze chemical reactions.

The mine bacteria piqued Doudna's curiosity, but when Doudna pried Crispr apart, she didn't see anything to suggest the bacterial immune system was related to the one plants and animals use. Still, she thought the system might be adapted for diagnostic tests.

Banfield wasn't the only person to ask Doudna for help with a Crispr project. In 2011, Doudna was at an American Society for Microbiology meeting in San Juan, Puerto Rico, when an intense, dark-haired French scientist asked her if she wouldn't mind stepping outside the conference hall for a chat. This was Emmanuelle Charpentier, a microbiologist at Umeå University in Sweden.

As they wandered through the alleyways of old San Juan, Charpentier explained that one of Crispr's associated proteins, named Csn1, appeared to be extraordinary. It seemed to search for specific DNA sequences in viruses and cut them apart like a microscopic multitool. Charpentier asked Doudna to help her figure out how it worked. "Somehow the way she said it, I literally—I can almost feel it now—I had this chill down my back," Doudna says. "When she said 'the mysterious Csn1' I just had this feeling, there is going to be something good here."

Back in Sweden, Charpentier kept a colony of *Streptococcus pyogenes* in a biohazard chamber. Few people want *S. pyogenes* anywhere near them. It can cause strep throat and necrotizing fasciitis—flesh-eating disease. But it was the bug Charpentier worked with, and it was in *S. pyogenes* that she had found that mysterious yet mighty protein, now renamed Cas9. Charpentier swabbed her colony, purified its DNA, and FedExed a sample to Doudna.

Working together, Charpentier's and Doudna's teams found that Crispr made two short strands of RNA and that Cas9 latched onto them. The sequence of the RNA strands corresponded to stretches of viral DNA and could home in on those segments like a genetic GPS. And when the Crispr-Cas9 complex arrives at its destination, Cas9 does something almost magical: It changes shape, grasping the DNA and slicing it with a precise molecular scalpel.

Here's what's important: Once they'd taken that mechanism apart, Doudna's postdoc, Martin Jinek, combined the two strands of RNA into one fragment—"guide RNA"—that Jinek could program. He could make guide RNA with whatever genetic letters he wanted; not just from viruses but from, as far as they could tell, anything. In test tubes, the combination of Jinek's guide RNA and the Cas9 protein proved to be a programmable machine for DNA cutting. Compared to TALENs and zinc-finger nucleases, this was like trading in rusty scissors for a computer-controlled laser cutter. "I remember running into a few of my colleagues at Berkeley and saying we have this fantastic result, and I think it's going to be really exciting for genome engineering. But I don't think they quite got it," Doudna says. "They kind of humored me, saying, 'Oh, yeah, that's nice.'"

On June 28, 2012, Doudna's team published its results in *Science*. In the paper and in an earlier corresponding patent application, they suggest their technology could be a tool for genome engineering. It was elegant and cheap. A grad student could do it.

The finding got noticed. In the 10 years preceding 2012, 200 papers mentioned Crispr. By 2014 that number had more than tripled. Doudna and Charpentier were each recently awarded the $3 million 2015 Breakthrough Prize. *Time* magazine listed the duo among the 100 most influential people in the world. Nobody was just humoring Doudna anymore.

Most Wednesday afternoons, Feng Zhang, a molecular biologist at the Broad Institute of MIT and Harvard, scans the contents of *Science* as soon as they are posted online. In 2012, he was working with Crispr-Cas9 too. So when he saw Doudna and Charpentier's paper, did he think he'd been scooped? Not at all. "I didn't feel anything," Zhang says. "Our goal was to do genome editing, and this paper didn't do it." Doudna's team had cut DNA floating in a test tube, but to Zhang, if you weren't working with human cells, you were just screwing around.

That kind of seriousness is typical for Zhang. At 11, he moved from China to Des Moines, Iowa, with his parents, who are engineers—one computer, one electrical. When he was 16, he got an internship at the gene therapy research institute at Iowa Methodist hospital. By the time he graduated high school he'd won multiple science awards, including third place in the Intel Science Talent Search.

When Doudna talks about her career, she dwells on her mentors; Zhang lists his personal accomplishments, starting with those high school prizes. Doudna seems intuitive and has a hands-off management style. Zhang ... pushes. We scheduled a video chat at 9:15 pm, and he warned me that we'd be talking data for a couple of hours. "Power-nap first," he said.

Zhang got his job at the Broad in 2011, when he was 29. Soon after starting there, he heard a speaker at a scientific advisory board meeting mention Crispr. "I was bored," Zhang says, "so as the researcher spoke, I just Googled it." Then he went to Miami for an epigenetics conference, but he hardly left his hotel room. Instead Zhang spent his time reading papers on Crispr and filling his notebook with sketches on ways to get Crispr and Cas9 into the human genome. "That was an extremely exciting weekend," he says, smiling.

Just before Doudna's team published its discovery in *Science*, Zhang applied for a federal grant to study Crispr-Cas9 as a tool for genome editing. Doudna's publication shifted him into hyperspeed. He knew it would prompt others to test Crispr on genomes. And Zhang wanted to be first.

Even Doudna, for all of her equanimity, had rushed to report her finding, though she hadn't shown the system working in human cells. "Frankly, when you have a result that is exciting," she says, "one does not wait to publish it."

In January 2013, Zhang's team published a paper in *Science* showing how Crispr-Cas9 edits genes in human and mouse cells. In the same issue, Harvard geneticist George Church edited human cells with Crispr too. Doudna's team reported success in human cells that month as well, though Zhang is quick to assert that his approach cuts and repairs DNA better.

That detail matters because Zhang had asked the Broad Institute and MIT, where he holds a joint appointment, to file for a patent on his behalf. Doudna had filed her patent application—which was public information—seven months earlier. But the attorney filing for Zhang checked a box on the application marked "accelerate" and paid a fee, usually somewhere between $2,000 and $4,000. A series of emails followed between agents at the US Patent and Trademark Office and the Broad's patent attorneys, who argued that their claim was distinct.

A little more than a year after those human-cell papers came out, Doudna was on her way to work when she got an email telling her that Zhang, the Broad Institute, and MIT had indeed been awarded the patent on Crispr-Cas9 as a method to edit genomes. "I was quite surprised," she says, "because we had filed our paperwork several months before he had."

The Broad win started a firefight. The University of California amended Doudna's original claim to overlap Zhang's and sent the patent office a 114-page application for an interference proceeding—a hearing to determine who owns Crispr—this past April. In Europe, several parties are contesting Zhang's patent on the grounds that it lacks novelty. Zhang points to his grant application as proof that he independently came across the idea. He says he could have done what Doudna's team did in 2012, but he wanted to prove that Crispr worked within human cells. The USPTO may make its decision as soon as the end of the year.

The stakes here are high. Any company that wants to work with anything other than microbes will have to license Zhang's patent; royalties could be worth billions of

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AMY MAXMEN (@amaxmen) *writes about science for* National Geographic, Newsweek, *and other publications. This is her first article for* WIRED.

dollars, and the resulting products could be worth billions more. Just by way of example: In 1983 Columbia University scientists patented a method for introducing foreign DNA into cells, called cotransformation. By the time the patents expired in 2000, they had brought in $790 million in revenue.

It's a testament to Crispr's value that despite the uncertainty over ownership, companies based on the technique keep launching. In 2011 Doudna and a student founded a company, Caribou, based on earlier Crispr patents; the University of California offered Caribou an exclusive license on the patent Doudna expected to get. Caribou uses Crispr to create industrial and research materials, potentially enzymes in laundry detergent and laboratory reagents. To focus on disease—where the long-term financial gain of Crispr-Cas9 will undoubtedly lie—Caribou spun off another biotech company called Intellia Therapeutics and sublicensed the Crispr-Cas9 rights. Pharma giant Novartis has invested in both startups. In Switzerland, Charpentier cofounded Crispr Therapeutics. And in Cambridge, Massachusetts, Zhang, George Church, and several others founded Editas Medicine, based on licenses on the patent Zhang eventually received.

Thus far the four companies have raised at least $158 million in venture capital.

Any gene typically has just a 50-50 chance of getting passed on. Either the offspring gets a copy from Mom or a copy from Dad. But in 1957 biologists found exceptions to that rule, genes that literally manipulated cell division and forced themselves into a larger number of offspring than chance alone would have allowed.

A decade ago, an evolutionary geneticist named Austin Burt proposed a sneaky way to use these "selfish genes." He suggested tethering one to a separate gene—one that you wanted to propagate through an entire population. If it worked, you'd be able to drive the gene into every individual in a given area. Your gene of interest graduates from public transit to a limousine in a motorcade, speeding through a population in flagrant disregard of heredity's traffic laws. Burt suggested using this "gene drive" to alter mosquitoes that spread malaria, which kills around a million people every year. It's a good idea. In fact, other researchers are already using other methods to modify mosquitoes to resist the *Plasmodium* parasite that causes malaria and to be less fertile, reducing their numbers in the wild. But engineered mosquitoes are expensive. If researchers don't keep topping up the mutants, the normals soon recapture control of the ecosystem.

Push those modifications through with a gene drive and the normal mosquitoes wouldn't stand a chance. The problem is, inserting the gene drive into the mosquitoes was impossible. Until Crispr-Cas9 came along.

Today, behind a set of four locked and sealed doors in a lab at the Harvard School of Public Health, a special set of mosquito larvae of the African species *Anopheles gambiae* wriggle near the surface of shallow tubs of water. These aren't normal Anopheles, though. The lab is working on using Crispr to insert malaria-resistant gene drives into their genomes. It hasn't worked yet, but if it does ... well, consider this from the mosquitoes' point of view. This project isn't about reengineering one of them. It's about reengineering them all.

Kevin Esvelt, the evolutionary engineer who initiated the project, knows how serious this work is. The basic process could wipe out any species. Scientists will have to study the mosquitoes for years to make sure that the gene drives can't be passed on to other species of mosquitoes. And they want to know what happens to bats

Find, Cut, and Replace for DNA

The gene-editing possibilities for Crispr-Cas9 are limited only by scientific creativity—and ethics. The mechanism was discovered in bacteria—it's an immune response that destroys the genetic material of invading viruses—but smart lab work turned it into an unrivaled tool for rapid, affordable, and precise genome modification. Here's how the process works. —VICTORIA TANG

Find

The Crispr-Cas9 system has two parts: a guide RNA (gRNA) that acts like a targeting device and a protein (Cas9) that acts like scissors.

Jennifer Doudna (opposite page) and Emmanuelle Charpentier did early work on Crispr.

and other insect-eating predators if the drives make mosquitoes extinct. “I am responsible for opening a can of worms when it comes to gene drives,” Esvelt says, “and that is why I try to ensure that scientists are taking precautions and showing themselves to be worthy of the public’s trust—maybe we’re not, but I want to do my damnedest to try.”

Esvelt talked all this over with his adviser—Church, who also worked with Zhang. Together they decided to publish their gene-drive idea before it was actually successful. They wanted to lay out their precautionary measures, way beyond five nested doors. Gene drive research, they wrote, should take place in locations where the species of study isn’t native, making it less likely that escapees would take root. And they also proposed a way to turn the gene drive off when an engineered individual mated with a wild counterpart—a genetic sunset clause. Esvelt filed for a patent on Crispr gene drives, partly, he says, to block companies that might not take the same precautions.

Within a year, and without seeing Esvelt’s papers, biologists at UC San Diego had used Crispr to insert gene drives into fruit flies—they called them “mutagenic chain reactions.” They had done their research in a chamber behind five doors, but the other precautions weren’t there.

Church said the San Diego researchers had gone “a step too far”—big talk from a scientist who says he plans to use Crispr to bring back an extinct woolly mammoth by deriving genes from frozen corpses and injecting them into elephant embryos. (Church says tinkering with one woolly mammoth is way less scary than messing with whole populations of rapidly reproducing insects. “I’m afraid of everything,” he says. “I encourage people to be as creative in thinking about the unintended consequences of their work as the intended.”)

Ethan Bier, who worked on the San Diego fly study, agrees that gene drives come with risks. But he points out that Esvelt’s mosquitoes don’t have the genetic barrier Esvelt himself advocates. (To be fair, that would defeat the purpose of a gene drive.) And the ecological barrier, he says, is nonsense. “In Boston you have hot and humid summers, so sure, tropical mosquitoes may not be native, but they can certainly survive,” Bier says. “If a pregnant female got out, she and her progeny could reproduce in a puddle, fly to ships in the Boston Harbor, and get on a boat to Brazil.”

These problems don’t end with mosquitoes. One of Crispr’s strengths is that it works on every living thing. That kind of power makes Doudna feel like she opened Pandora’s box. Use Crispr to treat, say, Huntington’s disease—a debilitating neurological disorder—in the womb, when an embryo is just a ball of cells? Perhaps. But the same method could also possibly alter less medically relevant genes, like the ones that make skin wrinkle. “We haven’t had the time, as a community, to discuss the ethics and safety,” Doudna says, “and, frankly, whether there is any real clinical benefit of this versus other ways of dealing with genetic disease.”

That’s why she convened the meeting in Napa. All the same problems of recombinant DNA that the Asilomar attendees tried to grapple with are still there—more pressing now than ever. And if the scientists don’t figure out how to handle them, some other regulatory body might. Few researchers, Baltimore included, want to see Congress making laws about science. “Legislation is unforgiving,” he says. “Once you pass it, it is very hard to undo.”

In other words, if biologists don’t start thinking about ethics, the taxpayers who fund their research might do the thinking for them.

All of that only matters if every scientist is on board. A month after the Napa conference, researchers at Sun Yat-sen University in Guangzhou, China, announced they had used Crispr to edit human embryos. Specifically they were looking to correct mutations in the gene that causes beta thalassemia, a disorder that interferes with a person’s ability to make healthy red blood cells.

The work wasn’t successful—Crispr, it turns out, didn’t target genes as well in embryos as it does in isolated cells. The

The gRNA—made of two subtypes, tracrRNA and crRNA—looks for specific genomic DNA in any organism and then sticks to corresponding bases.

The tracrRNA/crRNA complex then grabs the protein Cas9, floating nearby.

Cut

Cas9 grasps and cleaves the double-stranded genomic DNA spotted by the gRNA.

Replace

With the free end of the genomic DNA strand now accessible, researchers can apply a number of modifications, including inserting or deleting genes.

Refine

Different gRNAs that target different sequences can combine with different Cas proteins, each with a slightly different cutting capability.

Francesco Muzzi

Bryan Derballa (Doudna); Baerbel Schmidt (Charpentier)

Feng Zhang was awarded the Crispr patent last year.

Chinese researchers tried to skirt the ethical implications of their work by using nonviable embryos, which is to say they could never have been brought to term. But the work attracted attention. A month later, the US National Academy of Sciences announced that it would create a set of recommendations for scientists, policymakers, and regulatory agencies on when, if ever, embryonic engineering might be permissible. Another National Academy report will focus on gene drives. Though those recommendations don't carry the weight of law, federal funding in part determines what science gets done, and agencies that fund research around the world often abide by the academy's guidelines.

The truth is, most of what scientists want to do with Crispr is not controversial. For example, researchers once had no way to figure out why spiders have the same gene that determines the pattern of veins in the wings of flies. You could sequence the spider and see that the "wing gene" was in its genome, but all you'd know was that it certainly wasn't designing wings. Now, with less than $100, an ordinary arachnologist can snip the wing gene out of a spider embryo and see what happens when that spider matures. If it's obvious—maybe its claws fail to form—you've learned that the wing gene must have served a different purpose before insects branched off, evolutionarily, from the ancestor they shared with spiders. Pick your creature, pick your gene, and you can bet someone somewhere is giving it a go.

Academic and pharmaceutical company labs have begun to develop Crispr-based research tools, such as cancerous mice—perfect for testing new chemotherapies. A team at MIT, working with Zhang, used Crispr-Cas9 to create, in just weeks, mice that inevitably get liver cancer. That kind of thing used to take more than a year. Other groups are working on ways to test drugs on cells with single-gene variations to understand why the drugs work in some cases and fail in others. Zhang's lab used the technique to learn which genetic variations make people resistant to a melanoma drug called Vemurafenib. The genes he identified may provide research targets for drug developers.

The real money is in human therapeutics. For example, labs are working on the genetics of so-called elite controllers, people who can be HIV-positive but never develop AIDS. Using Crispr, researchers can knock out a gene called *CCR5*, which makes a protein that helps usher HIV into cells. You'd essentially make someone an elite controller. Or you could use Crispr to target HIV directly; that begins to look a lot like a cure.

Or—and this idea is decades away from execution—you could figure out which genes make humans susceptible to HIV overall. Make sure they don't serve other, more vital purposes, and then "fix" them in an embryo. It'd grow into a person immune to the virus.

But straight-out editing of a human embryo sets off all sorts of alarms, both in terms of ethics and legality. It contravenes the policies of the US National Institutes of Health, and in spirit at least runs counter to the United Nations' Universal Declaration on the Human Genome and Human Rights. (Of course, when the US government said it wouldn't fund research on human embryonic stem cells, private entities raised millions of dollars to do it themselves.) Engineered humans are a ways off—but nobody thinks they're science fiction anymore.

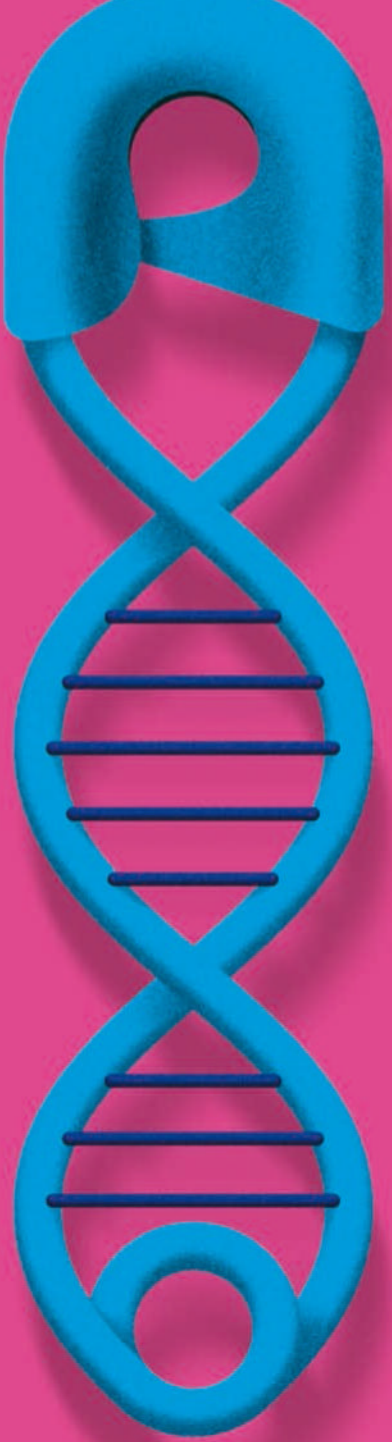
Even if scientists never try to design a baby, the worries those Asilomar attendees had four decades ago now seem even more prescient. The world has changed. "Genome editing started with just a few big labs putting in lots of effort, trying something 1,000 times for one or two successes," says Hank Greely, a bioethicist at Stanford. "Now it's something that someone with a BS and a couple thousand dollars' worth of equipment can do. What was impractical is now almost everyday. That's a big deal."

In 1975 no one was asking whether a genetically modified vegetable should be welcome in the produce aisle. No one was able to test the genes of an unborn baby, or sequence them all. Today swarms of investors are racing to bring genetically engineered creations to market. The idea of Crispr slides almost frictionlessly into modern culture.

In an odd reversal, it's the scientists who are showing more fear than the civilians. When I ask Church for his most nightmarish Crispr scenario, he mutters something about weapons and then stops short. He says he hopes to take the specifics of the idea, whatever it is, to his grave. But thousands of other scientists are working on Crispr. Not all of them will be as cautious. "You can't stop science from progressing," Jinek says. "Science is what it is." He's right. Science gives people power. And power is unpredictable.

Researchers in China announced they had used Crispr to edit human embryos.

Matthew Monteith



A TOUCH OF DUPLASS

BY
JASON TANZ

THIS IS JAY & MARK. THEY'RE BROTHERS. THAT MOVIE YOU LIKE? THEY MADE IT. OR WERE IN IT. OR FINANCED IT. MEET HOLLYWOOD'S UNLIKELY NEW JUGGERNAUT.

BRENT HUMPHREYS

THE

STREETS OF DOWNTOWN Austin are stirring blearily to life as the turducken street taco that is SXSW—a weeklong tech expo wrapped inside a film festival and finished off with a music showcase—shakes off the previous night's revelry. But backstage at the Austin Convention Center, where he is due to deliver the film festival's keynote address, director-producer-writer-actor Mark Duplass is rested and alert. His father is here, and so is his agent, and so is a tray of pastries, which Mark eyes warily.

Mark is a 38-year-old former athlete—he ran track in high school—and he possesses that strain of shticky carb anxiety common to the contemporary middle-aged male. His Twitter bio reads, "Resisting donuts, daily." On December 18 he tweeted, "I want a donut so goddamn bad my heart hurts." Tomorrow he will give an interview to Salon in which he refers to them as a source of "extreme joy" followed by intense regret: "With years of therapy, we've been able to extend that doughnut joy from the 12 seconds of eating to another three minutes before the shame." The point is, Mark is used to regulating his impulses for his own protection, and that's why he eschewed yesterday's industry parties and screenings in favor of a couple of miles on the treadmill and eight hours of sleep and why now, while the rest of the city struggles to rouse itself, he is full of energy and ready to take the stage.

Judging purely by his résumé, Mark is a fitting keynote speaker for SXSW's maximalism. As an actor, he has securely attained oh-hey-*that*-guy status. You might recognize him as the smirky Pete from FXX's fantasy-football comedy series *The League* or the competitively sensitive midwife Brendan on Fox's *The Mindy Project* or the tightly wound, undersexed Brett in HBO's *Togetherness*. But to the people filing into the auditorium, he is better known as one half of the Duplass brothers, an indie-film juggernaut that has written, directed, or had a hand in producing 24 movies over the past 19 years—including four new films screening at *this very festival*—not to mention *Togetherness*, every episode of which they wrote, produced, and directed. Beyond their prodigious output, Mark and his brother, Jay, 42, are celebrated for creating an entirely new model of DIY filmmaking, one tailor-made for the Netflix era of digital distribution. Twenty years ago every young director dreamed of becoming the next Quentin Tarantino. Today they all want to be a Duplass brother.

"They are singularly the most informed and instinctive filmmakers and businessmen in the industry," says Ted Sarandos, Netflix's chief content officer. "They know how to get a film made, and they know how to get it seen."

The Duplass brothers' movies tend toward finely wrought portrayals of human frailty, but Mark takes the stage with preternatural confidence, his name projected in giant letters behind him like Charles Foster Kane's at a political rally, his shirtsleeves rolled up and ready

MATTHEW TAPIA

PROP STYLING BY ANTHONY A. ALTOMARE; GROOMING BY ANNA BERNABE AT EXCLUSIVE ARTISTS FOR DAVINES HAIR CARE; STYLING BY APRIL STEINER AT EXCLUSIVE ARTISTS

Mark (left) and Jay Duplass are famous for reverse-engineering a movie to fit the available props, scenery, and actors.

for business. In interviews, Mark comes across as a Guy Who Has All the Answers, so it's not unreasonable to expect that he will have some advice for young filmmakers looking to storm the studio system. As he begins his talk, though, his hands press against the sides of the podium and his eyes take on the kind-but-firm look of a parent telling his children the truth about the Easter Bunny: It ain't happening.

"If you're at all like me and you read the trades and are involved in film conversations, it's mostly bad news," Mark begins. "What we hear about is the death of the middle class of independent films. Where are those cool $5 million movies that used to break out of Sundance in 1998? Why are they not buying those or making those, or even when they do, why are they not promoting them, and why is nobody going to see them?" This brings Mark to his thesis: No deep-pocketed studio executive is going to ride to your rescue. "The cavalry is not coming."

Then again, enterprising filmmakers are no longer confined to the conventional studio system. By now it's obvious that platforms like HBO and Netflix have made TV a destination for ambitious, big-budget projects like *Game of Thrones* and *House of Cards*. What's less remarked upon is that they have also provided an alternate economy for the kinds of scrappy passion projects that once filled art house cinemas. These digital platforms hew to different business models than the open-huge-or-go-home traditional movie industry. HBO judges success not just by the number of viewers a show receives but by its cultural impact. Amazon favors shows that draw a small but dedicated audience instead of a broad but less passionate viewership. And Netflix bases its acquisition offers on the projected size of a property's audience. After all, it's fine to draw only a tenth of the audience of *The Avengers*, as long as your film cost only a tenth as much.

And nobody has taken advantage of those new business models like the Duplasses. They're proponents of what they call the "available-materials school of filmmaking," a bare-bones philosophy of reverse-engineering a movie to fit the scenery, props, and actors at their disposal. (They wrote their first completed feature film, a road movie called *The Puffy Chair*, around the fact that they had a spare van and a deal on some matching recliners.) They also keep salaries low—in the early days, $100 a day was common—in favor of doling out percentages of the eventual gross. It also helps that they edit footage on laptops, allowing them to often keep production costs under $1 million. (One Duplass brothers production, Sean Baker's *Tangerine*, was shot entirely on an iPhone 5s.)

That's why if you've seen the movies they've written, directed, or produced—including *The One I Love*, a couples-therapy session by way of Borges; *Safety Not Guaranteed*, a time-travel romcom; *The Do-Deca-Pentathlon*, in which two adult brothers work out their frustrations through a series of adolescent sporting events; and even inexpensive studio films like *Cyrus*, an Oedipal love triangle starring Jonah Hill, or the Jason Segel–led *Jeff, Who Lives at Home*, about a guy looking for wood glue and the meaning of life—it was most likely on your couch, which is really a perfectly appropriate venue for such intimate fare. We tend to think of technology in Hollywood as a way of raising the stakes: higher budgets, bigger explosions, sassier robots. But in this case, technology has helped the Duplasses aggressively lower the stakes, carving out a healthy career making small films on paltry budgets for relatively small audiences.

LEIF PARSONS

THE MAKING OF THE MOGULS

Over the years, Mark and Jay Duplass have worn about every hat there is to wear in the movie industry. Here's how they built their empire.
—JORDAN CRUCCHIOLA

1996
Connect 5
Mark: Ⓟ Ⓐ
Jay: Ⓟ Ⓐ

The first film made under the Duplass Brothers Productions banner.

2003
This Is John
Mark: Ⓟ Ⓦ Ⓐ
Jay: Ⓓ Ⓒ

The brothers make their Sundance debut with this short film, made on a budget of $3—the price of one MiniDV tape.

2005
The Puffy Chair
Mark: Ⓟ Ⓓ Ⓦ Ⓐ
Jay: Ⓟ Ⓓ Ⓦ

"Not all movies are movies you want to spend $14 on—and not all movies are movies you want to spend $10 on for ultra VOD, or even $6.99 on renting," Mark tells me later that evening, at a Duplass Brothers Productions party that he will duck out of before midnight. "*The One I Love* came out in theaters for the enthusiasts and did a chunk of business on VOD. But when it started streaming on Netflix, it *exploded*. Same thing with *Safety Not Guaranteed*. I'm kind of homing in on this model."

Maintaining a vision this modest requires vigilance. Hollywood has a history of taking promising young auteurs, throwing enormous budgets at them, punishing them when their films inevitably fail to earn out—and turning them into megalomaniacs along the way. It's hard to imagine *Apocalypse Now*–era Francis Ford Coppola resisting many doughnuts, metaphorical or literal.

But by continuously policing their ambitions, the Duplasses have been able to build an entire ecosystem for making the kinds of character-driven dramedies that the industry has all but abandoned. Mark concludes his keynote by reiterating his admonition to ignore the false lure of Hollywood success. Take it from him: Even if you become an indie-cinema celebrity with dozens of films and a successful HBO series under your belt, the cavalry is not coming. But then he gets to the kicker.

"The good news is, who gives a fuck about the cavalry?" he says. "Because now *you* are the cavalry."

A COUPLE OF MONTHS after SXSW, I meet with Mark and Jay for breakfast at LA's Chateau Marmont. I won't bother to describe the restaurant because you've probably already read about it in 100 other Hollywood profiles, but I will tell you that the concordance-seeking journalist in me is tickled to realize that its address on Sunset Boulevard probably places it not too far up the road from where Norma Desmond voiced her famous lament: "I *am* big, it's the *pictures* that got small."

The Duplasses roll in around 9:30 am, exhausted and overwhelmed. It turns out that they've been in Detroit, filming for an undisclosed project. They had gone to bed around 6 the previous morning, then woke up a few hours later so they could fly home in time to put their kids to bed. Their body clocks were all screwed up, so they hadn't slept much, despite the fact that Jay had self-medicated with Benadryl.

Mark, who carries himself with the ease of someone used to being on camera, is able to hide his fatigue behind a kind of reflexive gregariousness. Jay, the more guarded and also more bearded Duplass, only recently became publicly recognizable, thanks to his role as damaged lothario Josh in the Golden Globe–winning Amazon series *Transparent*. (He also played a midwife—brother to Mark's—on *The Mindy Project*.) They are both, I am reliably told, eminently crushworthy. Within a certain population, "Jay or Mark?" is the indie-cinema equivalent of picking the hunkiest *Twilight* vampire. (Not long ago, my wife awoke from a deep slumber with the realization that she had switched sides.)

Mark and Jay grew up in Metairie, an anodyne suburb of New Orleans. They started making movies on their dad's Panasonic when they were 6 and 9, respectively, shooting renditions of *The Lone Ranger* and the Sermon on the Mount. Looking back on this early period, the brothers recall a spirit of loose-limbed experimentation, speaking with fondness for an improvised monologue about train hopping, "overly serious mood

THE FAILURE LEFT THE DUPLASSES WITH NO MONEY, NO PROSPECTS, AND A HARROWING LACK OF FAITH IN THEIR FILMMAKING ABILITIES.

COURTESY OF TROMA ENTERTAINMENT (*CONNECT 5*); SONY PICTURES CLASSICS/EVERETT COLLECTION (*BAGHEAD*); FOX SEARCHLIGHT/EVERETT COLLECTION (*CYRUS*)

KEY
Ⓟ = Producer
Ⓓ = Director
Ⓦ = Writer
Ⓐ = Actor
Ⓒ = Cinematographer

2007

Hannah Takes the Stairs
Mark: Ⓦ Ⓐ

The buzzy feature turns the Duplasses into indie darlings—and symbols of the burgeoning mumblecore scene.

2008

Baghead
Mark: Ⓟ Ⓓ Ⓦ
Jay: Ⓟ Ⓓ Ⓦ Ⓒ

Nights and Weekends
Jay: Ⓐ

The film is shot for $60,000 and filmed without permits outside Austin. Every member of the cast and crew serves as a “semi-producer.”

2009

Other People’s Parties
Mark: Ⓐ

Humpday
Mark: Ⓐ

True Adolescents
Mark: Ⓐ

The League (FX)
Mark: Ⓐ

2010

Greenberg
Mark: Ⓐ

Mars
Mark: Ⓐ

Lovers of Hate
Mark: Ⓟ
Jay: Ⓟ

Bass Ackwards
Mark: Ⓟ

The Freebie
Mark: Ⓟ

Cyrus
Mark: Ⓓ Ⓦ
Jay: Ⓓ Ⓦ

Mark and Jay’s first studio-produced movie.

2011

Kevin
Mark: Ⓟ
Jay: Ⓟ Ⓓ Ⓦ Ⓒ

Your Sister’s Sister
Mark: Ⓟ Ⓐ

Jeff, Who Lives at Home
Mark: Ⓓ Ⓦ
Jay: Ⓓ Ⓦ

Slacker 2011
Jay: Ⓓ Ⓐ

2012

Black Rock
Mark: Ⓟ Ⓦ
Jay: Ⓟ

Safety Not Guaranteed
Mark: Ⓟ Ⓐ
Jay: Ⓟ

The first Duplass Brothers Productions project since *Connect 5* without Jay or Mark credited as either writer or director.

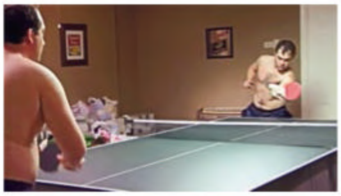
Darling Companion
Mark: Ⓐ

People Like Us
Mark: Ⓐ

Zero Dark Thirty
Mark: Ⓐ

The Do-Deca-Pentathlon
Mark: Ⓟ Ⓓ Ⓦ
Jay: Ⓟ Ⓓ Ⓦ

Debuts online 10 days before its theatrical release—the brothers’ first ultra-VOD title.



The Mindy Project (FOX)
Mark: Ⓐ
Jay: Ⓐ

pieces,” and an impression-heavy satire of the extended Duplass family, which “was a big hit at Christmas.”

Things got more serious once Jay realized, after four years as a psychology major at the University of Texas at Austin, that he had no interest in continuing in the field. He stayed in school an extra year to study film, enlisting his brother, who had also enrolled there, to act in his student projects—mostly overly cutesy bits of precious absurdity, inspired by the Duplasses’ obsession with the Coen brothers. (“We were trying to be them,” Mark says. “It was not going good.”) In 1996 Jay started an editing business wherein he and Mark charged $5 an hour to cut the movies of the Linklater spawn who were popping up all over Austin.

Eventually Jay got a lucrative commission to shoot a documentary about gardening, a bit of sponsored content on behalf of a deep-pocketed Austin startup called Gardening.com. The company folded before the film was finished but not before paying for it, and that gave the brothers the money to buy a Canon GL1, hire a camera operator and a director of photography, and start work on their second scripted feature, a Rocky-in-running-shoes rip-off called *Vince Del Rio.*

Before the brothers had finished editing it, they decided it was unreleasable. Mark has publicly referred to the result as “a pile of steaming elephant dung” and “a steaming pile of dog diarrhea.”

“The process got mechanized, and we made a boring-ass movie,” Jay says. Mark adds, “We didn’t trust our caveman approach—that our lack of knowledge is an extreme asset for creating a look and feel. It would be like if Kurt Cobain got music lessons and learned how to play a very clean Stratocaster.”

The failure left the Duplasses with no money, no prospects, and a harrowing lack of faith in their filmmaking abilities. In desperation, Mark decided that they were going to make a movie the way they used to as kids—fast and cheap and off-the-cuff. What was an idea for a small film they could make *that afternoon*? Jay recounted a recent near breakdown he’d had while trying to record the outgoing message on his answering machine. Mark ran out, bought a $3 MiniDV tape—an outlay that represents the movie’s only production cost—and improvised the entirety of what would become 2003’s *This Is John*. In the seven-minute short, what begins as a casual exercise ends up provoking a psychological collapse, as John rejects his various attempts as overly formal or self-conscious. The film ends with John committing to one final attempt at the outgoing message, which proves to be a display of burn-it-all-down self-acceptance that concludes, “Have a great fucking day.” It’s a trajectory that succinctly recapitulated the Duplasses’ creative journey up to that point.

This Is John may have looked and sounded

While the movie hits theaters in October, it is available on demand in August.

Another ultra-VOD premiere. By the end of the year, it will gross twice as much from on-demand revenue as from box-office earnings.

The duo's first original television show, it paves the way for an overall deal to develop and produce series for HBO—including the animated *Animals*, which the network bought after Sundance.

2013

Maron (IFC)
Mark: Ⓐ

Bad Milo!
Mark: Ⓟ
Jay: Ⓟ

Parkland
Mark: Ⓐ

2014

The One I Love
Mark: Ⓟ Ⓐ
Jay: Ⓟ

The Skeleton Twins
Mark: Ⓟ
Jay: Ⓟ

Adult Beginners
Mark: Ⓟ
Jay: Ⓟ

Creep
Mark: Ⓟ Ⓦ Ⓐ

Wedlock
Mark: Ⓟ Ⓐ
Jay: Ⓟ

Transparent
(Amazon Studios)
Jay: Ⓐ

Tammy
Mark: Ⓐ

Mercy
Mark: Ⓐ

2015

January 23:
Duplass Brothers Productions signs a four-picture deal with Netflix after Sundance.

Togetherness (HBO)
Mark: Ⓟ Ⓓ Ⓦ Ⓐ
Jay: Ⓟ Ⓓ Ⓦ

The Lazarus Effect
Mark: Ⓐ

The Bronze
Mark: Ⓟ
Jay: Ⓟ

Tangerine
Mark: Ⓟ
Jay: Ⓟ

Manson Family Vacation
Mark: Ⓟ
Jay: Ⓟ Ⓐ

6 Years
Mark: Ⓟ
Jay: Ⓟ

The Overnight
Mark: Ⓟ

Vimeo and FilmBuff acquire distribution rights after the web series debuts at South by Southwest.

The Sundance darling is shot entirely on an iPhone 5s.

like a home movie, but it had a rude life to it, and when the Duplasses submitted it to Sundance, it was accepted into the shorts program, where it was hailed as one of the five short films to see.

Two years later the brothers returned to Sundance with *The Puffy Chair*. Another largely improvised endeavor that drew on their personal lives, *The Puffy Chair* starred Mark as a narcissistic, struggling music promoter trying to decide whether to marry his needy girlfriend, played by Mark's real-life girlfriend at the time, Katie Aselton. "We were at an interesting point in our relationship—it was shit-or-get-off-the-pot time," Aselton says. In the film, the two characters get off the pot, while in real life, Mark and Katie shat (they are now married)—in part, Aselton says, because of the therapeutic effects of playacting their breakup. "It was a cathartic experience," she says. "I came out the other side saying, 'Glad I got that out, because I never want to say that in real life.'"

To some festivalgoers, the resulting film went beyond relatable to eerily familiar. "There were probably three sentences of dialog that I had said, verbatim, in my own life," says actor Josh Leonard, who befriended the Duplasses after seeing *The Puffy Chair* at a film festival in Woodstock. "It was this sense of 'Fuck you guys for knowing me so well—and I have to meet you.'"

Distributors stayed away from the picaresque, but after the film spent a year on the festival circuit, Red Envelope Entertainment, Netflix's nascent film-distribution arm, made it its first acquisition. The company partnered with Roadside Attractions on a limited theatrical release, but Netflix's Sarandos, who at the time ran Red Envelope, says he was mostly drawn to the film for its home-viewing potential. "There is no preciousness about distribution with them," he says. "They want people to see their movies, and they are willing to break glass to get people to see them."

By the time the Duplasses made their follow-up feature, 2008's *Baghead*—a light horror about a quartet of struggling filmmakers who retreat to the woods for a weekend in a last-ditch effort to write a feature movie that will jump-start their careers—they had found their sweet spot: rigorously plotted stories that gave the improvising actors a framework to explore the nuances of human interaction. (The tensest scene in *Baghead* is not when the four leads are chased by the eponymous homicidal maniac but when one character begs his more handsome friend not to sleep with a woman he likes.) The Duplasses were lumped together with directors like Andrew Bujaski and Joe Swanberg as part of a new movement, dubbed mumblecore. Not everyone was charmed. "The modestly named 'mumblecore' movement is not an earthquake like the French New Wave, more of a trembling in the shrubbery," Roger Ebert wrote in his *Baghead* review.

Nevertheless, the boys had momentum, and they soon had the opportunity to take the traditional next step in a burgeoning directing career—making their first studio film. They cast Jonah Hill, Marisa Tomei, and John C. Reilly—all *Puffy Chair* fans—in the Fox Searchlight-produced *Cyrus*. By most standards *Cyrus*, with a budget of $7 million and a creepy mother-son relationship at its core, would be considered fairly outré box-office fare, but to the Duplasses, the whole experience smacked of typical studio micromanagement. The brothers spent three years working on the film, a lifetime by Duplass standards.

"This is a movie about a very depressed man in his forties," Mark says. That proved to be an issue for Fox Searchlight, which was

COURTESY OF MAGNET RELEASING (*BAD MILO!*); COURTESY OF RADIUS-TWC (*THE ONE I LOVE*); COURTESY OF MAGNOLIA PICTURES (*TANGERINE*); JAIMIE TRUEBLOOD/HBO (*TOGETHERNESS*)

wary of alienating audiences. “If his apartment looks too dumpy, they’re going to lose money. They wanted him to be down but not *too* down. There was a heated discussion about throw pillows.” The film eventually grossed $7.4 million—by far the most successful Duplass venture to date—but if you look at the budget in the previous paragraph, you’ll see why this was considered a financial disappointment. The same was true of their next studio project, 2011’s *Jeff, Who Lives at Home*, which was a more freewheeling filmmaking experience but not any more successful, bringing in $4.2 million. “It broke our hearts,” Mark says now.

It was clear that the kind of movies the brothers liked to make were inherently limited in their box-office appeal—and that the traditional studio model wasn’t ever going to be a good fit. The brothers had been attached to a Scott Rudin–produced revamp of *Same Time, Next Year*, but the project stalled out. “We wanted to make the movie for $2 million,” Mark says. “Worst-case scenario, it makes $10 million and we’re a huge success. And they were just like, ‘That’s not our business.’”

Yet, while their films underperformed in theaters, many of them were enjoying a modestly lucrative afterlife on the small screen—a fact that heralded an alternative business model. The Duplasses had been flirting with HBO since *The Puffy Chair*, and this seemed like a good time to get serious. Jay had an idea for a series starring Steve Zissis, who had gone to high school with Mark and whose acting career had stalled out after his starring roles in *Baghead* and *Do-Deca-Pentathlon*. Together, they came up with an idea for *Alexander the Great*, a pilot about a struggling actor with mental-health issues. “HBO said, ‘We love it, but can you make it a relationship show with more characters?’” Zissis says. “We were like, ‘Yeah! We can do that!’ Meanwhile, we were shitting ourselves.” (You’ll notice that excrement is a recurring theme with these guys.) They returned with an exploration of the various midlife crises—marital, professional, financial, creative—that they and their friends were experiencing.

HBO green-lit the series and never pressured the brothers to broaden its appeal. “We try to give interesting options to people that they aren’t getting elsewhere,” says Casey Bloys, executive vice president of programming at HBO, which in January renewed *Togetherness* for a second season. “We don’t worry if a show is too small or too big.”

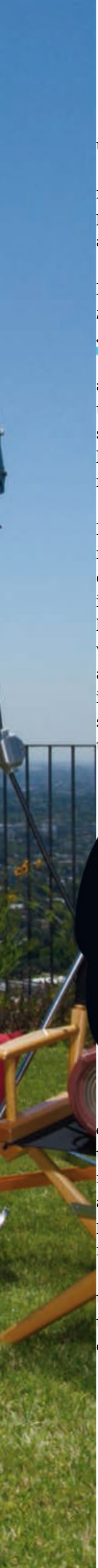
LAST YEAR, HANNAH FIDELL got a text message from Mark Duplass, asking if she was free to talk. Mark and Jay became fans after Fidell sent them her 2013 feature, *A Teacher*, before its Sundance premiere. So when Mark had a movie idea for a young-adult reboot of *Days of Wine and Roses*, with physical abuse instead of alcohol, he wanted her to make it. He could offer her a modest budget, producers, and casting help. He would also promise her complete artistic freedom and protection from any studio influence. Fidell accepted, and by the end of the day she was officially signed up to write and direct what would become *6 Years*. At SXSW in March, Netflix purchased it.

You hear these kinds of stories a lot when you start hanging around the Duplasses. J. Davis was working as an editor of corporate videos when he met Jay at a video store; they struck up a friendship, and Jay eventually encouraged him to make a movie about his obsession with Charles Manson. Jay ended up starring in the film as well as participating in a Kickstarter campaign to fund it, and *Manson Family Vacation* joined *6 Years* at SXSW, where it too was purchased by Netflix. The girlfriend of aspiring writer-director Patrick Brice was working as Mark and Katie’s nanny while Brice was at Cal Arts; Mark helped him with his thesis film, acted in and produced his first feature, *Creep*, and produced and helped cast Adam Scott, Taylor Schilling, and Jason Schwartzman in *The Overnight*. Liz Flahive and Jeff Cox, a married couple who wrote the Duplass-produced *Adult Beginners*, were offered Mark and Katie’s house as a workspace. “I got a group email from him,” Flahive says, “which said something like, ‘Katie and I have a house we’re not using right now because we’re working, so if you want to incubate a project or work on your album ...’ I was like, holy shit, this guy means it!”

It is perhaps the most surprising development in an already surprising career; the Duplasses have become micromoguls, helping filmmakers benefit from the business model they’ve developed. In 2008 they got a call from their friend Bryan Poyser, who was trying to scrape together $5,000 to finish a film. “He said, ‘My movie dies tomorrow without this,’” Jay remembers. The brothers had just received payment for the *Cyrus* screenplay, so they handed some of it over to Poyser and pitched in some editing help, which got them an executive producer credit. Their involvement also got the attention of the Sundance jury, which accepted the film into competition. “With a little bit of money and 15 hours of work, we changed his whole world and that whole film,” Jay says.

As Mark puts it, the revelation that they could rescue a struggling filmmaker’s career with just a little bit of time and money “blew

THEIR FILMS UNDERPERFORMED IN THEATERS BUT ENJOYED A LUCRATIVE AFTERLIFE ON THE SMALL SCREEN.



up in our heads” and tapped into a desire to save others from their own *Vince Del Rio*–style missteps. Since helping Poyser, they have produced multiple films a year (with at least four in 2015), all adhering to the philosophy of keeping costs down, protecting the filmmaker’s vision, and getting the movie in front of audiences as quickly as possible.

“Mark and Jay are amazing,” says Nick Kroll, who costars with Mark in *The League* and who conceived and starred in *Adult Beginners*. “We made our movie and then sold it, and now it’s coming out! Just like it’s supposed to happen but so rarely does.”

That process should be even smoother now that Netflix has signed a four-picture deal with Duplass Brothers Productions. “There are tons of inefficiencies in independent film distribution,” Sarandos says. “By the time something gets to Netflix, it’s several million dollars in the hole. So we said, ‘Why don’t you skip that process, come right to Netflix, and make money on every film?’ ”

Now the Duplasses are taking a similar approach to television. Last year they met with a couple of filmmakers who were trying to make a pilot for an animated series called *Animals*. “We said, ‘Don’t do it,’” Mark says. “If you’re lucky, you’ll sell it. If you’re even luckier, you’ll make a pilot, and then it won’t get picked up and you’ll have wasted two and a half years. We can’t pay you very much, but we’ll pay you enough to live and make all 10 episodes of your show, and then we’ll go out and sell it later.” HBO ended up not only buying those 10 episodes but also signing on for a second season at the same time. Four months later the network signed the brothers to a two-year development deal.

ON ONE HAND, THE DUPLASSES seem to have attained filmmaking nirvana: the ability to turn any idea, no matter how fleeting, into a profitable movie or TV show. “If we have an idea in the car on Friday at 9 am, and this is not hyperbole, by 3 that day I can have a writer, a cast, a producer, and be in preproduction,” Mark says. “Because we have the money to finance it, and we know all the people who want to do it.”

But if your tastes run to cautionary fables, then you’ll recognize the precariousness of the Duplasses’ current situation. For a team that has thrived within strict limits, the absence of traditional career obstacles can be perilous.

While the brothers are still happy making movies, they’ve found increasing success in helping other people make their own.

First and foremost is the very real danger that the Duplasses will simply work themselves to death. When Mark was in his late teens and early twenties, he had a flourishing career as a singer-songwriter, but he had to give it up when he developed tendinitis. (For a time he led another band, in which he played a special low-impact keyboard.) “I played acoustic guitar so intensely, for so long—for nine hours a day as a 10-year-old, writing songs through the night, on tour constantly from when I was 19—that I destroyed my arms and shoulders in the process,” Mark says. The pain—bad enough that Mark had to ask other people to open doors for him—lasted for about five years, through the shooting and screening of *The Puffy Chair* and all the attention that followed. “It was the height of my tenacity and the height of my working hard, and basically I had a mini nervous breakdown,” Mark says. “I was in a state of literally on-the-floor anxiety and depression for two months.” The relentless workaholism led Mark to confront his deep-seated depression, which he manages today. He stabilized, with the help of his wife and therapy and some antidepressants, but he tells me that he is constantly worried that he’ll slip back into that frenzy. “That’s why I’ve conscripted the people around me to watch out for me,” he says. “Left to my own devices and all my own work instincts, I’d just destroy myself.”

Already there are troubling signs. When Jay arrived at the Chateau Marmont, he complained that his grueling schedule had begun to take a physical toll. “Mark’s had a lot of body pain in the past, and I’m going through it right now,” he said. “I have all this shoulder and neck tension, which is pretty much the majority of my world right now.” (Pushing oneself to the point of bodily failure is something of a Duplassian leitmotif. Both *Do-Deca-Pentathlon* and *Togetherness* feature scenes of grown men exerting themselves until they vomit.)

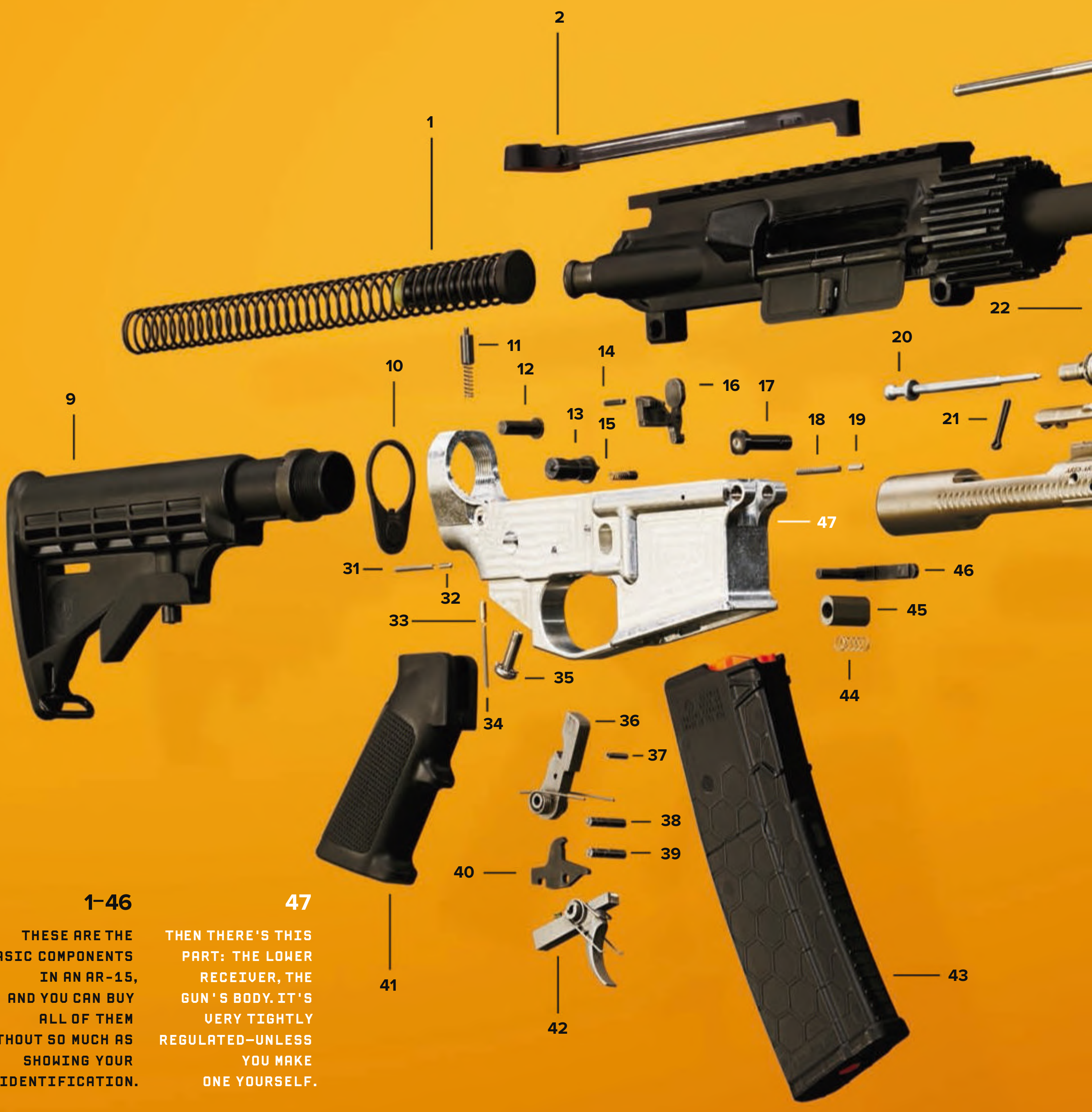
At the same time, it’s difficult to give any of this up after they’ve worked for so long to get here. “We went to Catholic prep school, and everyone we graduated with was rich and successful by the time they were 25,” Jay says. “We were extremely not-rich and extremely not-successful, even at 30. And we felt like, OK, we’ve chosen this unconventional path—if we let up and we don’t succeed, then we’re to blame.” It’s been hard to switch gears, to go from by-any-means-necessary to leave-a-message-with-my-people-and-we’ll-see-what-we-can-do. “We hit a point in our midthirties where there was so much stuff coming at us that we could eliminate all the dumb stuff,” Jay continues. “Now we’re in a weird position, where eliminating the dumb stuff is easy—now we have to eliminate the really cool things.”

Mark, sitting next to him at the Chateau Marmont, nods vigorously. It’s a problem he’s intimately familiar with: “How do you say no to doughnuts?” ▣

Editor at large **JASON TANZ** (@jasontanz) *wrote about the trust economy in issue 22.05.*

AR-15

SECRET



1–46

THESE ARE THE BASIC COMPONENTS IN AN AR-15, AND YOU CAN BUY ALL OF THEM WITHOUT SO MUCH AS SHOWING YOUR IDENTIFICATION.

47

THEN THERE'S THIS PART: THE LOWER RECEIVER, THE GUN'S BODY. IT'S VERY TIGHTLY REGULATED—UNLESS YOU MAKE ONE YOURSELF.

WEAPON

ANYONE CAN NOW BUILD AN UNTRACEABLE GUN WITH LITTLE MORE THAN AN ALUMINUM BLOCK AND A $1,500 COMPUTER-CONTROLLED MILL. I MADE ONE AT THE OFFICE.

BY ANDY GREENBERG

PHOTOGRAPH BY DWIGHT ESCHLIMAN

→ **THIS IS MY GHOST GUN.** To quote the Rifleman's Creed, there are many like it, but this one is mine. It's called a ghost gun—a term popularized by gun control advocates but increasingly adopted by gun lovers too—because it's an untraceable semiautomatic rifle with no serial number. It exists beyond law enforcement's knowledge and control. And if I feel a strangely personal connection to this lethal, libertarian weapon, it's because I made it myself, in a back room of WIRED's San Francisco office on a cloudy spring afternoon. ¶ I did this mostly alone. I have virtually no technical understanding of firearms and a Cro-Magnon man's mastery of power tools. Still, I made a fully metal, functional, and accurate AR-15. To be specific, I made the rifle's lower receiver; that's the heart of the gun, the only part that US law defines and regulates as a "firearm." All I needed for my entirely legal DIY gunsmithing project was about six hours, a basic understanding of computer software, a $68 chunk of aluminum, and a black, nearly featureless 1-cubic-foot desktop milling machine called the Ghost Gunner. ¶ The Ghost Gunner is a $1,500 computer-numerical-controlled mill sold by Defense Distributed, the gun-access activist group that gained notoriety in 2012 and 2013 when it began creating 3-D-printed gun parts and the world's first 3-D-printed pistol, the Liberator.

While the political controversy surrounding the notion of a lethal plastic weapon that anyone can download and print has waxed and waned, the gun control debate in America is still raging—a fire fed by June's mass shooting at Emanuel AME Church in Charleston, South Carolina. And though both sides in the argument focus mostly on guns you can buy at Walmart, Defense Distributed's DIY gun-making has now advanced from plastic to metal. Like other CNC mills, the Ghost Gunner carves an object out of aluminum based on instructions from a digital file. The first shipments of this sold-out machine started this spring, furthering Defense Distributed's aim of making it vastly easier for normal people to fabricate gun parts out of a material that's nearly as strong as the stuff used in industrially manufactured weapons. But the Ghost Gunner represents the evolution of amateur gun-making, not a revolution. Homebrew gunsmiths have been making ghost guns for years, manually machining lower receivers to legally assemble rifles that fall outside the scope of American firearm regulations. There's also Defense Distributed's previous trick: building plastic gun parts with a 3-D printer.

> A CALIFORNIA LAWMAKER INTRODUCED LEGISLATION TO BAN GHOST GUNS LAST YEAR. GOVERNOR JERRY BROWN VETOED IT.

I decided to build an untraceable AR-15 all three ways—with a drill press, a 3-D printer, and Defense Distributed's new gun-making machine—to see if the barrier to legally building an untraceable, durable, and deadly semiautomatic rifle has truly dropped to an unprecedented low in terms of cost and skill.

I'm going to give away the ending: It has.

ALMOST NO ONE CREATES a ghost gun from scratch, and I didn't either. The shortest path to an untraceable AR-15 requires only that you build the lower receiver, a part that's become the focus of a fierce gun control debate. US gun regulations have focused on the lower receiver because it's the linchpin of a rifle: It holds together the stock, the grip, the ammunition magazine, and the upper receiver, which includes the barrel and the chamber where the cartridge is detonated. As Doug Wicklund, senior curator for the NRA Museums, explained to me, the lower receiver always has carried the serial number because it's the part that remains when the others wear out and are replaced. Like the frame of a bicycle or the motherboard of a computer, it's the nucleus of the machine around which everything else is constructed.

It's worth noting that simply buying an AR-15 in the US isn't hard. As long as your gun meets local regulations—in California they call for a mechanism that inhibits rapid magazine changes—an AR-15 is just another semiautomatic rifle, which most Americans can own legally. But the privacy-minded—as well as those disqualified from gun purchases by criminal records or mental illness—can make their own lower receivers and purchase all the other parts, which are subject to nearly zero regulation. I ordered every part of my AR-15 but a lower receiver from the website of Ares Armor, a Southern California gun parts seller that doesn't require any personal information beyond a shipping address. If I wanted to further obscure my purchases, I could have paid in bitcoin; Ares accepts it.

There's even a way to anonymously buy that highly regulated central component—almost. Like many gun vendors, Ares sells what's known as an "80 percent lower," a chunk of aluminum deemed to be roughly 80 percent of the way toward becoming a functional lower receiver. Because it lacks a few holes and a single precisely shaped cavity called the trigger well, it's not technically a regulated gun part.

Machining the last bits myself with a CNC mill or a drill press would allow me to obtain a gun without a serial number, without a background check, and without a waiting period. I wouldn't even have to show anyone ID. Law enforcement would be entirely ignorant of my ghost gun's existence. And that kind of secrecy appeals to Americans—a few of whom I'd soon meet—who consider their relationship with their firearms a highly personal affair that the government should keep out of.

Controversy swelled around ghost guns in the summer of 2013, when John Zawahri, an emotionally disturbed 23-year-old, used one to kill five people in Santa Monica. Even so, they haven't been outlawed; buying or selling a ghost gun is illegal, but making one remains kosher under US gun control laws. California state senator Kevin de León introduced a bill to ban ghost guns last year, following the Santa Monica mass shooting. Governor Jerry Brown vetoed it a few months later. He said he didn't think it would make the public any safer.

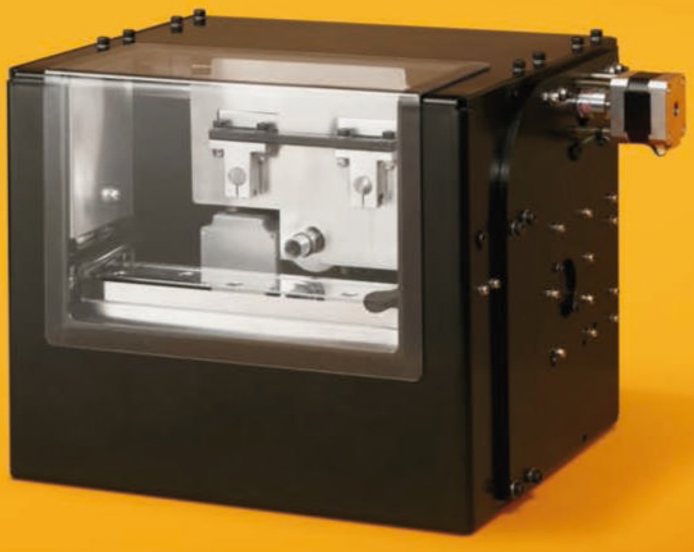
But despite the shouting match over ghost guns, few of the shouters have actually tried to make one. Even fewer have tried to test how the evolution of a new set of digital maker tools is changing that gun control question.

So over the course of one strange week in San Francisco, that's what I set out to do. Here's how it all went down.

→

ONE OF THESE PARTS IS NOT LIKE THE OTHERS: IT'S THE SHINY BIT, AND I MADE IT MYSELF.

PHOTOGRAPH BY JOSH VALCARCEL



DRILL PRESS

REMEMBER WHEN I SAID I know nothing about using power tools? Unsurprisingly, my attempt to fashion a lower receiver using a conventional drill press didn't go well.

Step one: Acquire a drill press, a massive stand-alone rig meant to cut the aluminum features out of my 80 percent lower. One $250 rental fee later, two colleagues helped me haul a nearly 6-foot-tall drill down to our building's loading dock, a dark and chilly concrete space occupied by a pair of large dumpsters. I'd paid Ares $97 for a set of steel-carbide drill bits and end mills—tools that act like bits but also can cut sideways like a milling machine—all of which the company recommended I use with the drill press to do the job. I paid another $135 for a set of steel jigs; those were metal stencils that would guide the machine as I tried to mill and drill precise shapes.

All that planning and spending, it turned out, couldn't compensate for my utter lack of even high-school-level shop skills. Before I'd even begun, I realized I had the wrong sort of vise, and we had to drive an hour and drop $80 to pick up another one. Then there was the drilling itself—which, it turned out, was not as easy as it looked on the Internet.

I reviewed my lower-receiver-drilling basics on YouTube one last time, put on latex gloves and eye protection, screwed the steel jigs around my slug of aluminum, tightened the clamps, and hit the chunky green power button.

As the drill bit chewed into the block, I felt a rush of excitement and tasted fine aluminum dust between my teeth. The bit threw off metal shavings and left behind a gleaming, polished crater. But my elation faded as I realized how badly I was mangling the trigger well. No matter how hard I cinched down the vise, it shuddered constantly, moving the aluminum piece. The holes I was cutting veered off until they were practically diagonal.

When I switched to the end mill to clean up the spaces between the pits I'd created, I found they were mostly at different depths: The drill bit had somehow moved up and down, and I hadn't noticed. The bottom of the cavity I'd made began to resemble the surface of the moon. Meanwhile, the massive machine protested loudly, shaking like a train about to derail.

I kept at it for five and a half hours. Then the head of the drill press—the part that holds the bit, which I would later learn is called the chuck—fell off. I had no idea whether this was supposed to happen as a kind of fail-safe or if I had destroyed an expensive piece of rented equipment. I screwed the chuck back in, and after a few more minutes of metal-on-metal violence, it dropped off again. (I still don't know if I damaged the drill press, but a gunsmith later explained to me that it likely wasn't designed to handle the lateral pressure of using it as a milling machine.)

That's when I gave up. I had nothing to show for my labor but a sad metal block scarred by a maze of crooked channels. Well, that and a left hand bristling with aluminum shrapnel where my latex glove had split.

3-D PRINTER

I LEFT THE GREASE-SOAKED drill press in WIRED's loading dock, headed back upstairs, and pulled a $2,900 MakerBot Replicator from its box. It felt like the elevator was a time machine shortcutting about a century of technological progress.

I plugged in the 3-D printer, followed a series of delightfully idiotproof instructions, and in minutes was test-printing a tiny white coffee table. Soon I was ready to start making gun parts; no obscure YouTube instruction videos, calipers, jigs, or aluminum splinters required.

I found the blueprint for a printable, reinforced AR-15 lower receiver on The Pirate Bay. It was one of dozens of gun parts avail-

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PHOTOGRAPH BY DWIGHT ESCHLIMAN

OPENING SPREAD, STYLING BY JAMES WHITNEY/ARTIST UNTIED

able for download in the rogue BitTorrent repository's Physibles section, a part of the website presciently created in 2012 to host controversial digital blueprints that other sites wouldn't or couldn't. In fact, the file I downloaded had been written by Defense Distributed in 2013, but the group had pulled it from its own website after the State Department basically threatened to prosecute the group's staff for weapons-export-control violations.

It took a few minutes to torrent the lower receiver file. I opened it in MakerBot's printing application, centered it on the app's digital representation of the machine's build plate, and clicked Print. The printer's motors began to whir, and within seconds its printhead was laying out extruded white plastic in a flat structure that vaguely resembled the body of a rifle. As the workday ended and WIRED's office emptied, I found myself sitting alone in a darkening room, transfixed by the gun component slowly materializing before me.

At one point, six hours into the nine-hour print job, the Replicator's printhead overheated and took some time to cool down. That required pressing one more button on the machine. I didn't touch it again. The next morning I came back to the still-dark room and found a finished, eerily translucent lower receiver glowing inside the Replicator's LED-lit chamber.

As science-fictional as that process felt, the reality fell short. When I pried the finished lower receiver off the print bed, one side was covered in support material meant to prevent the hot plastic structures from collapsing before they solidified. Snapping and scraping off that matrix of plastic was a long, messy process. I tried using a kitchen knife—all I could find in the office—cut my thumb, and bled all over one side of the rifle body. And the same support material also filled small holes in the piece, in some cases choking the delicate threads meant to accept metal screws.

It's clearly possible, based on YouTube evidence, to 3-D-print AR-15 lower receivers that are capable of firing hundreds of rounds. But mine wasn't so practical; I wouldn't know it until I visited a gunsmith two days later, but I'd eventually give up on assembling a gun out of that plastic-printed receiver long before it was anywhere close to becoming a functional weapon.

GHOST GUNNER

THE NEW GENERATION of maker machines, like 3-D printers and CNC mills, have been lauded as tools that allow anyone to make anything. But from my first moments using the Ghost Gunner, it was clear: This is a machine designed to make a gun.

Defense Distributed's CNC mill is a simple black cube, with two little motors sticking out of two of its sides. As if to underscore the power contained in its microwave-sized footprint, the machine was so heavy that I could barely lift it from its box. When I did haul it onto a table, I was struck by the lack of branding or any visual flourishes. Its stark simplicity mirrors the unmarked gun parts it's designed to mill.

← IT'S ONLY ABOUT THE SIZE OF A MICROWAVE, BUT THANKS TO SOLID METAL CONSTRUCTION, THE GHOST GUNNER (LEFT) IS SURPRISINGLY HEAVY.

The Ghost Gunner works with either of two pieces of software: Grbl, an open source, general-purpose milling application, or DDCut, a Windows-only gun-milling program created by Defense Distributed and recommended by the group for less experienced CNC mill users. The Ghost Gunner also comes with the DDCut instruction file for milling an AR-15 lower receiver, shipped on a USB thumb drive in the box. (Putting it on the Internet, as with the 3-D-printable files, might have prompted the State Department to threaten Defense Distributed with prosecution for weapons-export-control violations.)

I installed DDCut and found that for its primary purpose of finishing a lower receiver, the Ghost Gunner is absurdly easy to use—mostly because I was never given the chance to make any choices. Once DDCut began running the AR-15 file and cutting into my 80 percent lower, my only interactions with the software were clicking Next through a 22-step set of instructions and then doing things to the aluminum part that the software told me to do.

For one hour-long stretch in that process, I was given nothing to do but simply admire the Ghost Gunner as its blurred spiral blade cut away the gun's trigger well with inhuman precision. At other times it seemed to alternate between carving aluminum and assigning me tasks, like changing the lower receiver's position, tightening and loosening bolts, switching the end mill to a drill bit, and even vacuuming up the aluminum shavings that piled up in and around the machine. It felt much more like the Ghost Gunner had programmed me to be its gun-making tool than vice versa.

Over those hours, I couldn't help but appreciate the beauty of the Ghost Gunner's design and engineering. As it patiently removed metal, the aluminum piece and the cutting tool moved in robotic, mesmerizing patterns. The noises the machine produced alternated between high-pitched shrieking and low groaning that echoed through the WIRED newsroom and elicited puzzled looks from coworkers. But during quieter lulls, the Ghost Gunner also emitted a series of rising and falling harmonics, produced by vibrations of the mill's motors, that sounded like a kind of alien melody.

When it was only three steps away from finishing its full process, however, the Ghost Gunner hit a serious snag. The probe the mill uses to measure the lower receiver's location malfunctioned, and the machine locked itself. To get it moving again, I had to call Cody Wilson, Defense Distributed's cofounder, to seek advice. At first he told me I'd have to rerun the entire process—close to four hours of wasted time. "It's a design flaw," Wilson admitted. "If it stops, it has to start again from the beginning."

But Wilson soon came up with a better plan and sent me a new file that rehearsed only the last portion of the AR-15 cutting process. Twenty minutes later I pulled from the machine the shining, perfect body of a semiautomatic rifle, as warm as if it were some baked good fresh from the oven.

WHO BUYS A GHOST GUNNER?

IN A DUSTY STORAGE facility somewhere on the West Coast, a software engineer—let's call him John—leads me past rows of 1970s trailers, aging PVC-pipe art projects, and mutated bicycles: the collected detritus of a Burning Man collective. We arrive at a room-sized shipping container. John takes an expensive Swedish lock off the door and lets me peer inside. It's filled mostly with dusty air and cardboard crates. But he assures me this will soon be his personal armory, complete with two safes full of firearms in various states of completion and a Ghost Gunner grinding away at new ones.

A bald and perpetually black-shirted security engineer, John worked for years building networks as a military contractor in wartime Afghanistan and Iraq. In Baghdad, he lived outside the Green Zone. He already owns plenty of AR-15s. But "being able to buy them is one thing," he says. "Being able to make them is another."

John was Ghost Gunner customer number 12; he preordered the mill within hours of its announcement in October 2014 and received it this spring. At this moment he's letting a friend borrow it—or rather, buy it temporarily for $1, since sharing the gun-making tool might violate Bureau of Alcohol, Tobacco, Firearms and Explosives regulations.

As we drive to that friend's home, John explains that he's not just interested in the Ghost Gunner's law-hacking applications. He wants to use it to make gun parts beyond simple lower receivers—new kinds of custom muzzle brakes, scope mounts, and handgun bodies, or even objects unrelated to firearms that he hasn't yet dreamed up. He's hoping a full-blown DIY community will form around Defense Distributed's cheap, open source CNC mill, sharing 3-D design files for metal parts of all descriptions. "I think it could be a standardized cheap machine that will have enough of a user base for people to start making other stuff," he says. "If you build it, they will come."

But when we arrive at his friend's home, it's clear that some Ghost Gunner users are motivated by a simpler sort of defiance. "In California they don't like you to have AR-15s," says John's friend, a tall, gray-haired software engineer. The Ghost Gunner rests between us,

MY GHOST GUN BUDGET

Building an untraceable AR-15 with the Ghost Gunner is pricier than it would be with a traditional drill press. But it requires far less skill than that manual method and costs less than creating the gun with a typical 3-D printer. —A.G.

Drill Press Method

↓

Drill press rental	$250
End mills, drill bits	$97
Slide vise	$80
80-percent-lower jigs	$135
80 percent lower	$68
Upper receiver	$550
Trigger, hammer, grip, etc.	$75
Stock	$63
Magazine	$16
Total	$ 1,334

3-D Printer Method

↓

MakerBot Replicator	$2,900
Upper receiver	$550
Trigger, hammer, grip, etc.	$75
Stock	$63
Magazine	$16
Total	$ 3,604

Ghost Gunner Method

↓

Ghost Gunner	$1,500
80 percent lower	$68
Upper receiver	$550
Trigger, hammer, grip, etc.	$75
Stock	$63
Magazine	$16
Total	$ 2,272

← THE AUTHOR FIRES HIS GHOST GUN FOR THE FIRST TIME.

PHOTO BY JOSH VALCARCEL/WIRED

upside down on the coffee table of his beige-carpeted living room. "Well, it's the 21st century, and you can make them."

Since the Ghost Gunner's debut, Defense Distributed's tiny bootstrap operation has been flooded with demand; its initial run of 500 sold out in three days. Those customers have ranged from state-hating libertarians to first-adopter makers to doomsday preppers. Wilson says he believes Edward Snowden's surveillance revelations gave his company a boost too, inspiring a renewed sense of "rifle privacy." So, he says, has an ATF regulation that forbids so-called build parties, in which a gunsmith invites amateurs to their shop to take turns finishing 80 percent lowers with professional machinery; a January letter from the ATF declared the practice illegal. At least two groups—one in Texas and one in Kentucky—bought Ghost Gunners as collectives, with every member owning shares in the devices able to take turns churning out their own unregulated rifle parts.

Wilson, a 27-year-old dropout from the University of Texas law school, falls near the most radical edge of the Ghost Gunner spectrum. For the past three years, he's devoted his career to finding new ways in which code can outpace the law's ability to control it, from 3-D-printable guns to a bitcoin application designed to enable untraceable online payments to his latest interest in gun-making machines. And if one of those inventions were used to enable real violence? "Liberty is a dangerous thing," he says.

His goal with each of his public provocations, in fact, is not only to score points against the US government but to demonstrate how it has become impotent in the face of technology. The Ghost Gunner is his latest attempt to force a standoff: He decided on the device's name only after seeing gun control advocate De León say "ghost gun" in a press conference introducing his now-failed legislation. Wilson hopes to trademark the term. "Our strategy is to literalize and reify their nightmare," he says. "We're giving them the world they're talking about, and they're not fucking ready for it."

ASSEMBLY

AFTER TWO DAYS of work, I have three objects resembling AR-15 lower receivers. The one I finished with the Ghost Gunner looks superior to my 3-D-printed one—and even more obviously superior to the hot mess of uneven aluminum I'd chewed up with the drill press. But before assembling the full weapon, I want an expert opinion. So I visit Bay Area Gunsmithing, a sunny warehouse about 30 miles north of San Francisco, populated by two professional gunsmiths, a very impressive collection of firearms, and a gracefully aging dachshund named Ruth.

When I show my manually drilled lower receiver to Nathan Rynders, the shop's owner, he dismisses it immediately. The hammer and trigger wouldn't fit into the narrow, winding gorge of the trigger well I'd created, and I hadn't even gotten as far as drilling holes for the safety and trigger pins. (He does note that he's seen worse attempts, including a customer who brought him a lower receiver with a gaping, unintended orifice drilled through its side.)

I'm more surprised when Rynders insults my 3-D-printed lower receiver. "This is not ready to rock," he says, skeptically probing the part's details with his fingers. He points out that the blueprint made something called a "takedown-pin hole" too small, and he makes a further to-do list of necessary fixes before it could be assembled. "You'd need to clean out the buffer-tube threads and pistol-grip threads, clean up everything a pin went through," Rynders says. "You'd need several hours of labor to clean this thing up."

Just the idea of a 3-D-printed lower receiver bothers him; if the ring that held on the buffer tube and stock (the big loop at the back of the receiver) were to break, he points out, it could unleash a large and powerful spring inches from the shooter's face. "It scares me," Rynders says.

My Ghost Gunner–milled AR-15 body, by contrast, gets a stoic nod of approval. Rynders—who, allow me to stress, works with guns for a living—isn't exactly wowed that I've produced a functional, essentially flawless lower receiver. But he gives me the go-ahead to build it into a full rifle. "It's safe to assemble, safe to fire," he says. "Yes, you could put this together and it would be ready to go."

Over the next hour in Rynders' shop, I construct my AR-15. This is harder than Forrest Gump makes it look. But I persist, learning the process as I go by watching a YouTube video from Ares Armor a few seconds at a time. (A couple of times, Rynders can't help but point out that I have inserted a part backward or give me an unsolicited hint. I suppose this is cheating in what I hoped would be a one-man gunsmithing experiment, but unfortunately Rynders is a very friendly, helpful, and competent person.)

When I finally

| CONTINUED ON PAGE 98

Leila Janah's Not-So-Secret Plan to Find (Tech) Jobs for the World's Poorest

Helped 6,527 people find work

$4.7 million in wages since 2008

Work centers in 5 countries and 6 schools in the U.S.

Average salaries rose 175 percent

by **Jessi Hempel**

📷 **Jeremy Williams**

Her nonprofit helps people in developing countries get paid for digital labor. WIRED talks with Janah about putting them—and disadvantaged Americans—to work in the 21st century.

Leila Janah, founder and CEO of Sama Group

Fresh out of Harvard in 2005,

Leila Janah landed a job as a management consultant. One of her first assignments took her to Mumbai, where she traveled by auto-rickshaw to a sleek outsourcing center staffed by well-educated Indians from middle-class families. The ride took her past one of Asia's largest slums, Dharavi, where cholera outbreaks are commonplace and children die of preventable diseases. Outsourcing might have been providing millions of jobs, but it wasn't helping the country's poorest. She began to think, "Couldn't the people from the slums do some of this work?"

Janah, 32, turned that idea into a nonprofit that connects poor people to low-level tech work. She started Samasource—*Sama* is Sanskrit for "equal"—as an outsourcing company that hires people in Africa and Asia to perform digital tasks for companies like Google and LinkedIn. Thanks to Janah, more than 30 people in northern Uganda got work from Getty Images, tagging pictures of Andy Murray and Rihanna. All told, Samasource has helped 6,527 people in nine countries find employment.

Two years ago, she launched a job-training program for low-income workers in the US. It helps people plug in to on-demand services like Lyft, TaskRabbit, and Instacart. In one early class in East Palo Alto, California, a quarter of the participants had neither a smartphone nor Internet access at home. So far, grads have increased their income 27 percent on average, starting new jobs at $12.64 an hour. Dubbed Samaschool, the effort is now rolling out across the US and, thanks to an online curriculum, globally.

YOU HAVE A KIND OF HARD-HEADED IDEALISM. WHERE DID THAT COME FROM?

I grew up believing in meritocracy and the American dream. My parents came here from India. They had no connections. My brother and I went to public schools, and both of us succeeded.

YOU TOOK TIME OFF FROM HARVARD TO DO STINTS WITH THE SOCIAL ENTREPRENEURSHIP PROGRAM ASHOKA AND THE WORLD BANK. HOW DID THAT SHAPE YOUR VIEWS?

I emerged from that time pretty disillusioned with traditional thinking about aid. Every time I'd talk to poor people, they'd tell me they wanted the same thing: a job.

SO NATURALLY AFTER GRADUATION YOU BECOME A MANAGEMENT CONSULTANT.

I wanted to pay off my college loans and understand how to start a business. I was sent to go work for a big outsourcing company in India. The industry was creating millions of jobs in places that the West thought of as backwaters. But if you wanted to get a job at a call center, you had to come from a middle-class family. Very low-income people were not walking into Infosys and handing out their CVs!

That got me thinking: Maybe there's a way to use this model to help people in the slums, especially for some of the easier tasks like data entry.

HOW DID YOU GET FROM THERE TO SAMASOURCE?

I wrote a business plan for a data entry startup in Nairobi, hiring people from the slums. A lot of businesses say they're advancing social justice because they hire people from a poor country. But it was important to me to start this business in a way that would track people's income, find people below the poverty line, and move them above it.

I moved to Silicon Valley and pitched a bunch of VC firms. It became a nonprofit after I realized I could never raise money from investors for this idea. That was in 2008. We launched with one contract from a local nonprofit.

WHAT KIND OF WORK HAS SAMASOURCE HELPED PEOPLE GET OVERSEAS?

Getty was looking for vendors to tag photos they'd acquired when they bought iStockphoto. Machine learning can handle a lot of the image recognition, but images of celebrities from different angles or with shadows needed to be processed by a human.

We set up the project in northern Uganda, which is mostly known for child soldiers and extreme rural poverty. We hired local workers. An example of success is Juliet Ayot, who was an AIDS orphan. She took money she got from tagging pictures and bought two piglets. She was able to hire someone locally to tend her pigs. Now she has a piggery.

WHAT INSPIRED YOU TO START SAMASCHOOL?

We noticed our Samasource workers continued to make good incomes when they left. The earnings of the average worker in East Africa and Asia rose from $800 a year before Sama to $3,300 a year after, and stayed there. We realized that if we trained our workers how to find work for the Internet economy, we could boost our impact dramatically.

IN 2013 YOU LAUNCHED IN THE U.S. HOW DID THAT COME ABOUT?

I said, "Let's start, as an experiment, a lean startup within Sama." I hired a director from an organization that teaches job skills to foster-care youth. I said, "If you can train people and have them earn more money than it costs to train them over a period of three months, then we'll invest in it." That threshold was $1,200 in extra income. After three months, people were making, on average, $2,000 more.

YOU STARTED IN PARTNERSHIP WITH THE YMCA IN SAN FRANCISCO'S IMPOVERISHED BAYVIEW NEIGHBORHOOD. HOW DID IT EXPAND FROM THERE?

We were approached by a community college in Northern California, which has a lot of rural poverty. They approved our online curriculum so people could sign up and take Samaschool as a class. Since then we've expanded to several cities in California and one site in Arkansas. We've just started conversations with the Robin Hood Foundation to do the training in New York.

WHAT KINDS OF JOBS ARE YOU PREPARING PEOPLE FOR?

When we started, there were two tracks—jobs you could do in person via TaskRabbit and Internet jobs that required generally higher skills, like being a virtual assistant or doing data entry. Now we realize there are a lot more local service-type jobs, like Instacart, Uber, Lyft, and Care.com.

SOME PEOPLE VIEW THOSE STARTUPS AS EXPLOITING PEOPLE FOR JOBS THAT OFFER FEW BENEFITS AND NO WAY TO ADVANCE.

The benefit to this model is that it's much cheaper to train people to be successful, because a lot of them have traditional skills that can be repurposed really quickly for moneymaking. For example, we had a kid who'd had no formal job but liked to work on cars. His brothers had been involved in the drug trade in the Bayview, which is the only economic opportunity there for a lot of young men of color. He got his first job on TaskRabbit installing car stereos. The first month he made several hundred dollars doing something he loved.

Yes, the downside is these are not 9-to-5 jobs that have a pension at the end, but those jobs are disappearing.

WHERE DO YOU START WITH THE TRAINING?

At the very beginning. We help people set up their profiles, use the right keywords, identify where they might have skills that would be a good fit for these jobs, and we teach them how to apply. In some areas where there is very low technology literacy, like Arkansas, even just navigating a user interface is very foreign to people.

By the time they finish, they have already applied for several jobs. They have profiles on several online worksites. In some cases we will have them apply for a job and do the job, assisted through the class. A challenge is free Wi-Fi. We create a coworking space where people can come back every week and review their job applications with one of our instructors, and then, importantly, we teach them the finance side of things. For example, how to deal with self-employment tax.

ARE YOU BOTHERED BY THE FACT THAT THESE JOBS DON'T COME WITH TRADITIONAL BENEFITS?

Yes! There aren't any unions for online workers. That's because this industry hasn't been around long enough for people to really get organized. But that could happen. It's much easier for people to compare wages or identify bad employers or discuss bad labor practices in the Internet economy than it was in, say, a factory environment, where that stuff wasn't usually published or available.

WHAT NEEDS TO HAPPEN FOR THE WORKFORCE TO EVOLVE?

Government could set up better systems for independent contractors to receive health care, benefits, even child care, in a very different way from how it used to be done. So maybe, instead of having low corporate tax rates where companies are expected to pay for all those things, we shift the burden to public funding and have higher capital gains taxes for investors and the companies that are designing these systems.

THAT PERSPECTIVE MUST MAKE YOU POPULAR IN THE VALLEY.

Many tech entrepreneurs are not opposed, in principle, to giving away some of their wealth to benefit the most vulnerable people in society. They don't want to live in a place where nobody can afford their products. They want to live in a country with a strong middle class.

A lot of people are happy to give money to charities but are wary of giving through taxes because they feel it doesn't produce any value. The challenge is that we haven't seen political leadership inspired enough to develop solutions. I wish the city of San Francisco, bastion of liberalism, were more innovative when it comes to how to spread the wealth.

"There aren't any unions for online workers. They haven't had time to organize. But that could happen."

JESSI HEMPEL (@jessiwrites) *is senior staff writer at* WIRED.

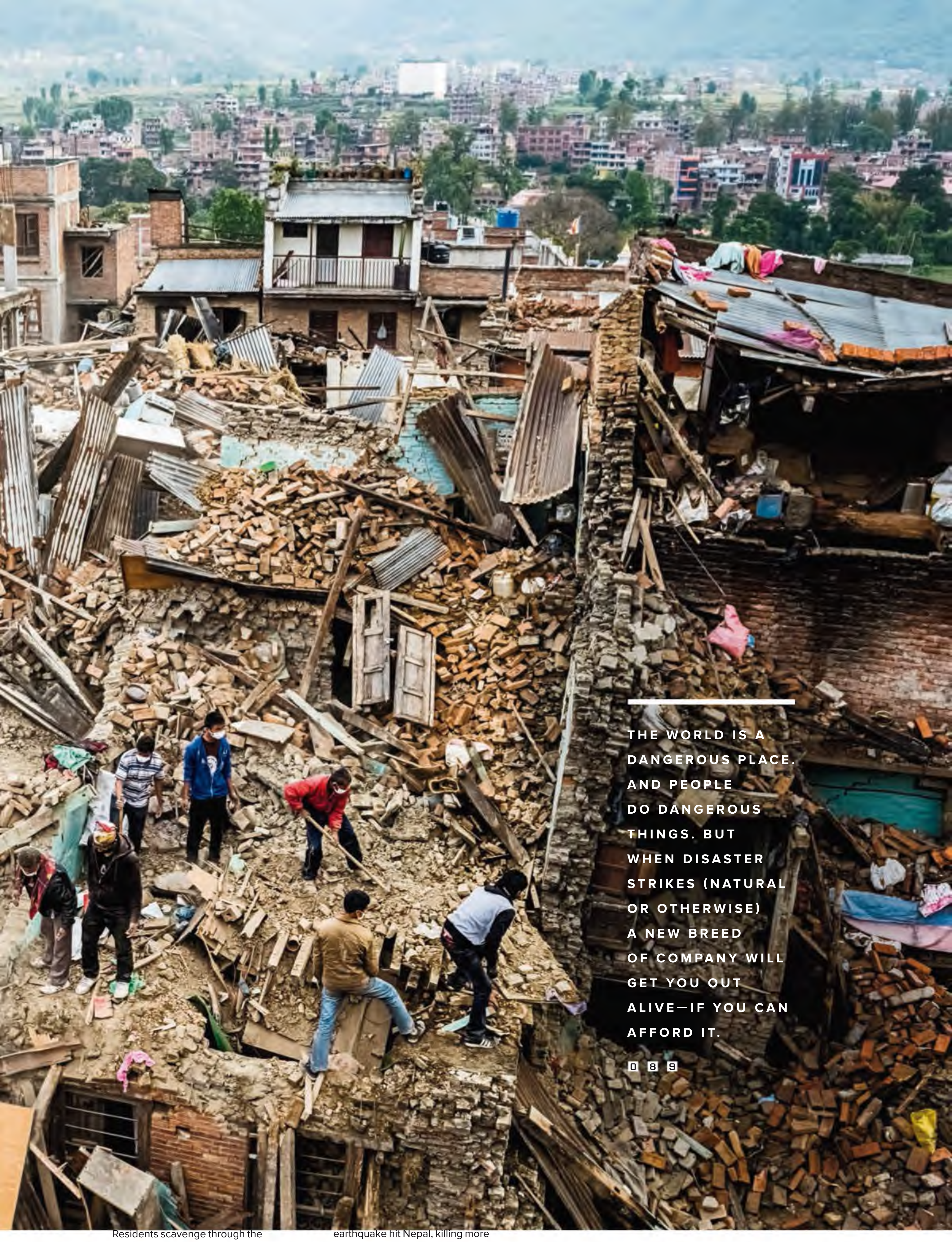
PREVIOUS SPREAD: GROOMING BY AMY LAWSON/ARTIST UNTIED; THIS SPREAD: COURTESY OF SAMASOURCE

SOS, INC.

BY ABE STREEP

PHOTOGRAPH BY **DANIEL BEREHULAK**

KATHMANDU, NEPAL



THE WORLD IS A DANGEROUS PLACE. AND PEOPLE DO DANGEROUS THINGS. BUT WHEN DISASTER STRIKES (NATURAL OR OTHERWISE) A NEW BREED OF COMPANY WILL GET YOU OUT ALIVE—IF YOU CAN AFFORD IT.

Residents scavenge through the rubble of their destroyed homes four days after a 7.8-magnitude earthquake hit Nepal, killing more than 8,000 people and flattening buildings and ancient temples.

KATHMANDU, NEPAL

In retrospect, the choice to book a ground-floor room was a sound one.

On Saturday, April 25, Andy Fraser lay in bed at the Rokpa Guest House, a modest three-story hotel in Nepal's ancient capital, a city of 1 million sunk in a valley bordered by the Himalayan range. Fraser, a powerfully built 38-year-old British wilderness paramedic with a shaved head and prominent brow, had arrived a few weeks earlier for an extended business trip. A lifelong adventurer, he'd cut his teeth in London's frenetic ambulance service, taught English at a salmon farm on an island in Chile, and spent six months treating snakebites at a clinic in rural Zambia. Recently, though, things had changed. He'd gotten engaged to another British paramedic, Becky, and with 40 approaching, he'd decided he needed to find what he called "a real job."

He'd sought out a position with Global Rescue, a private crisis-response firm, and in his first year on the job was dispatched to Nepal for the Himalayan climbing season. Global Rescue, which positions itself as a nimble eject button for those who frequently find themselves in tough spots, has in the past decade established a lucrative client base of large corporations, government organizations, hunters, and adventure travelers. The company has offices in New Hampshire, Massachusetts, Pakistan, and Thailand and a staff that might make some countries' armies blush. Its roster of 200-odd employees includes wilderness paramedics and former military personnel, some of them ex–Special Forces and Navy SEALs. The company's Nepal posting is a busy one. Every spring, climbers and trekkers, many of them Global Rescue clients, come to test their mettle in the Himalayas. In 2013 and 2014, the company evacuated 28 clients and repatriated the remains of three more who perished in the mountains.

So far, though, it had been a quiet month. The mountaineers were acclimatizing on the lower regions of the Himalayas' iconic peaks: Makalu, Lhotse, and Mount Everest. Fraser's job in Kathmandu was to assist members in need of medical care or evacuation. He called Becky around noon on Skype, as she was just waking up in England. The couple said good morning, then Fraser's room began to move. It was a steady, primal roll, like a turbulent ocean. "Holy shit," Fraser told his fiancée. "I think there's a fucking earthquake." Then the Wi-Fi connection died. He fell off the bed, pulled on a shirt, hurtled out, and started banging on doors, yelling at his neighbors to leave the hotel. The floor lurched, the walls swayed. Fraser sprinted for the door, assuming the building was coming down. When he reached the lawn he started screaming up at the hotel's windows: Get out! Staffers and guests ran out of the building and onto the lawn. Fraser was shocked the Rokpa didn't collapse.

This had been a long time coming. The last major earthquake in Nepal took place in 1934, an 8.0 temblor that flattened Kathmandu. Before that Saturday in April, seismologists had been warning of another Big One for years. Noting Kathmandu's dense population center and the country's poor infrastructure—Nepal is currently ranked 145th out of 187 on the United Nations' human development report—some observers predicted as many as 100,000 deaths in the event of another 8.0 tremor. At 7.8, the quake that struck on April 25 was smaller than many anticipated. But it was shallow, causing violent shaking on the surface. And at two long minutes, the quake's duration was the seismic equivalent of a Jimmy Page solo. When it stopped, Fraser heard screaming. He sent a message to Hassan Anderson, a colleague in Global Rescue's Bangkok office, via Line, the free communication app, saying, "Big earthquake here."

BANGKOK, THAILAND

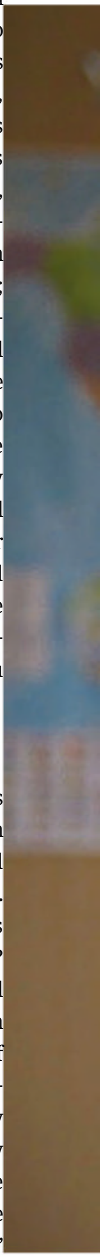
When the message arrived, Anderson, a 45-year-old paramedic from Philadelphia who, like Fraser, sports a shaved head, thought he was joking. He'd been a Navy reserve corpsman for nearly a decade and later worked as a paramedic in Afghanistan. His days were now spent on the 22nd floor of a high-rise in Bangkok's business district, at Global Rescue's Thailand Operating Center, a large space for 20 full-time employees complete with a medical equipment room and two rows of eight desks that sit in front of a panel of flatscreen TVs playing a steady stream of world news. The wall of light presented no news of an earthquake, so Anderson replied: "Stop farting."

And then news of the disaster broke on television in Bangkok. Then Kathmandu's cellular network went down, overloaded by the volume of calls, and Line stopped working. On cue, Global Rescue's phones lit up. Uber, a corporate client, had three employees in Kathmandu. Another corporate client, Condé Nast, WIRED's parent company, called: A climber was on assignment for *Glamour*. Another call came from Virginia Commonwealth University in Qatar, which had staff in Nepal. Two Global Rescue analysts began sifting through Twitter feeds from Everest climbers they'd been following. But there was precious little to report. Wi-Fi was down in Kathmandu, cell phone service was sporadic, and satellite phones went in and out.

By 7:15 pm that Saturday in Bangkok, Anderson had fielded 10 calls. Over and over he recited the emergency responder's rote reassurances: Be patient, it's a fluid situation, we'll keep you updated. Before bed, one of his bosses, operations supervisor Steve Bright, called and told him to pack a bag—he was going to Kathmandu.

LOS ANGELES, CALIFORNIA

The company's founder and CEO, a former Wall Street executive named Dan Richards, awoke on Saturday morning to many voicemails. He was on vacation in Los Angeles; back in Boston and New Hampshire, his team was awake and scrambling. Analysts eventually determined that at least 100 clients were in Nepal. Their specific locations, though, were less clear. Climbers on Everest were moving slowly up the mountain, spread between Base Camp, at 17,600 feet; Camp 1, at 19,800 feet; and Camp 2, some 2,000 feet higher. Early Saturday morning in the US, the first reports had emerged of a massive and deadly avalanche of rock and ice at Base Camp. Richards had no idea if his clients were among the deceased. He contacted his associate director for security operations, Scott Hume, who then instructed Drew Pache, a security operations manager for Global Rescue and former US Army Special Forces operative, to leave the New Hampshire office and get on a plane for Kathmandu. Richards was concerned about Fraser—Kathmandu was still rumbling with aftershocks.



In an age when travelers can land in Paris or Jakarta and book a ride with Uber before the plane reaches the gate, Global Rescue's existence hardly seems remarkable. Why shouldn't we be able to hire private armies to ensure our safe return home from vacation? Fast convenience has never been so valued, and Global Rescue represents a logical extension in the app era: security guaranteed with the click of a sat phone. That's what the company sells, anyway—absolute control in situations that are by definition uncontrollable. The truth is slightly more complicated. "It's a bit like a swan in the water," Fraser told me. "It looks graceful on the surface, but underneath, the legs are going crazy."

The fact that well-heeled travelers can summon Green Berets and wilderness paramedics

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PREVIOUS SPREAD: THE NEW YORK TIMES/REDUX

FRASER'S ROOM BEGAN TO MOVE. IT WAS A STEADY, PRIMAL ROLL, LIKE A TURBULENT OCEAN. THE FLOOR LURCHED. THE WALLS SWAYED. "HOLY SHIT," HE SAID. "I THINK THERE'S A FUCKING EARTHQUAKE."

PHOTOGRAPH BY **ADAM FERGUSON**

ANDY FRASER

A Global Rescue senior specialist, Fraser was on call in Kathmandu when the 7.8 temblor shook the city and threw the country into chaos.

almost instantaneously can present an ethical conundrum. The places where Global Rescue operates are often poor and short on resources; the company's business model is predicated on delivering goods and services to its clients first. It makes an effort to help locals when possible, but as Richards puts it, "We are not the Red Cross. We don't have the ability to just deploy our services to people who haven't paid a membership fee."

A graduate of Dartmouth's Tuck School of Business, Richards founded Global Rescue in 2004 following a successful career as a private equity adviser at Thomas Weisel Capital Partners. He saw a niche that needed filling. At the time, companies like International SOS provided risk assessments to big corporations sending employees overseas, while travel insurance companies allowed customers to file for reimbursement for services like evacuation or lost luggage. Groups like MedjetAssist, meanwhile, provided evacuation services from international hospitals. But there wasn't a company with the capability to quickly dispatch both helicopters and security personnel to hard-to-reach places—something Richards realized while researching investment opportunities in the crisis-response industry. "When you call the cavalry, you expect the cavalry to show up," he says.

Richards soon hired five paramedics with military experience, negotiated a partnership with the Johns Hopkins Department of Emergency Medicine to provide clients with remote medical consultations, and started reaching out to helicopter companies and current and former military personnel around the globe that he could hire on a contract basis. He began to sign up corporate clients that paid hefty annual fees for memberships that included evacuation privileges. The State Department, NASA, and Uber soon signed up for similar deals. So did many publishing companies, including National Geographic and Condé Nast. Some *Outside* writers, myself included, also have memberships. In the past five years, Global Rescue has become the safety net of choice for adventure travelers, many of whom opt for the company's two-tiered membership program for individuals. Medical coverage costs $329 per year, while medical plus security runs $655. It's something like AAA—most clients won't need the insurance, but for those who do, the cost of their evacuation is covered. The American Alpine Club offers a limited Global Rescue service to all its members; ask a climber if they've heard of Global Rescue and chances are they'll produce a membership card.

Richards built Global Rescue into a juggernaut. "They changed the industry and made the existing players look at their offerings and make adjustments," one veteran crisis-response official told me. But the CEO also developed a reputation as a very competitive and hard-driving boss. In 2011 five high-ranking employees, including two vice presidents, left the company within a month. The VPs, a former US Army Ranger named Tom Bochnowski and a former Navy SEAL named Ted Muhlner, soon started a competing outfit, Redpoint Resolutions. Based in Silicon Valley, Redpoint packages medevac services alongside travel insurance—you can call them in the event of a lost bag as well as a lost limb. The company took more than one Global Rescue employee and client with it. Bochnowski wouldn't comment directly on Global Rescue, citing a 2011 breach of contract lawsuit between the two companies. He did say, "We're able to put the consumer at the center of our services. It's a bigger vision than what we were able to accomplish in our past jobs."

Still, despite the competition, it's been a good few years for Global Rescue's bottom line. In 2012 the company opened offices in Islamabad, Pakistan, as well as Bangkok. Members are given one number to call, which is routed to whichever office is open. Running such a sprawling operation requires a global network of reliable contractors as well as the ability to quickly establish communication in places that don't have it. Employees in the field use a text-only satellite device called a DeLorme InReach, as well as a satellite-enabled modem system that creates a mini wireless network. Then there's the company's newly developed GRID app, which sends real-time security alerts to a client's smartphone—a faster, more accurate version of the State Department's travel advisories. For all the tech, though, says Pache, the former Special Forces operative, "it comes down to a guy on the ground exercising good judgment and doing the best he can with what he's got."

LUKLA, NEPAL

In Nepal, that person was Fraser. He spent a harrowing night on the Rokpa's lawn alongside the hotel's other guests while a dozen aftershocks rumbled. At one point, he was envious of a neighbor, an American who was able to sleep on the grass through the seismic highlight reel. Then a stray, a rangy mutt, walked up, raised its leg, and calmly urinated all over the American, who slept on.

In the morning, Fraser sent an SMS message to Bangkok, telling his bosses he was going to fly to Lukla, the small mountain town 85 miles to the east that serves as the jumping-off point for most major Himalayan climbs and treks. A Swiss doctor named Monika Brodmann Maeder, who happened to be in Kathmandu, was on the helicopter flight to Lukla with Fraser; when the two arrived, they found an eerily quiet scene. The hospital was damaged, and a few volunteer nurses were trying to set up a makeshift triage ward in the airport. No patients had arrived yet.

They quickly hashed out a diagnostic system: Fraser would give patients a rapid once-over as they were unloaded. Thumbs up meant they went to the nurses; down sent them to Brodmann Maeder for critical care. Then the helicopters started coming in. Here was a broken back. Here a shattered pelvis. A climber with a head injury got off a helicopter and started walking aimlessly in the direction of its tail rotor. Most of the helicopters were small, four-person rigs. Sometimes, though, a big Mi-17 showed up. "Every time it turned up my heart sank," Fraser says, "because I knew there were 20 people in it." By late afternoon he had triaged about 70 patients, most of them Nepalis. No one knows how many of the patients died. He flew back to the capital. It was time to do his real job.

KATHMANDU

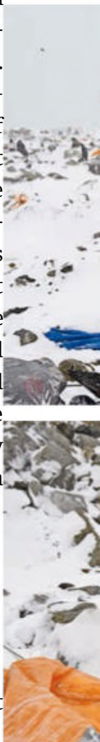
When he landed he rendezvoused with Anderson, who had arrived from Bangkok and spent the afternoon negotiating a maelstrom at the airport. Upon arriving, Anderson reached out to Uber's three employees, who were camping on the lawn outside the Hyatt Regency before their flights out. The team looked through their client list. A group of three climbers was on Lhotse, a neighbor of Everest, but they had called in to say they were OK. Another client, a Colorado climber named Brad Johnson, was high on Makalu. He too was in decent shape, with the exception of a painful back.

Global Rescue clients seemed to have evaded the carnage. None were among the 18 casualties from the Everest Base Camp avalanche. There were hurdles to overcome, to be sure—Nepal's government had commandeered all of the country's private helicopters, meaning that the company couldn't make good on its promise to quickly deliver air evacs to clients like Johnson, who needed to get off Makalu before his back worsened. The team kept a spreadsheet with four active tabs: situation unknown, safe and accounted for, evacuation in progress, and closed operation. By Monday, April 27, they had moved 49 clients into the latter three tabs. None had required medical treatment. Overall, they felt like they were in good shape. That's when the call came in about the team at Camp 1.

FAIRFAX, VIRGINIA

Kathy McKnight's first thought was "My God. Not again."

The 52-year-old education researcher was returning from a triathlon training run near her home in Fairfax when her brother-in-law called to tell her there had been an earthquake



ROBERTO SCHMIDT/AFP/GETTY IMAGES

in Nepal and that there were reports of a massive avalanche at Everest Base Camp. McKnight's husband, Patrick, a 49-year-old psychology research professor at George Mason University, was making his second attempt to reach the top of the world. The previous year, Patrick, a seasoned mountaineer, arrived in Base Camp just an hour after an avalanche ripped through the Khumbu Icefall, a treacherous half-mile section of shifting glacier bordered by rock faces between Base Camp and Camp 1. That slide killed 16 Sherpas and ended Everest climbing from the Nepal side in 2014. Now he was back on the mountain with the same guiding company he'd chosen the previous year, Summit Climb, an outfitter based in Seattle.

Patrick's brother told Kathy there was no reason to panic just yet. Patrick had a SPOT device, a subscription-based emergency satellite beacon that's tapped into international search-and-rescue networks. He had linked his SPOT to his blog and Facebook and Twitter accounts via the connection app If This Then That, and starting at 3:17 am Eastern—about an hour after the earthquake hit—he had released a series of three location dispatches placing him at Camp 1, obviously a message to his family. Plus, Kathy knew her husband was a Global Rescue member. But there was no reason to get too comfortable. At 1:27 pm Nepal time—3:42 am Eastern—Summit Climb's leader, a 55-year-old guide named Dan Mazur, tweeted, "Aftershock @ 1pm! Horrible here in Camp 1. Avalanches on 3 sides." Half an hour later, he tweeted again about the situation on Everest. This time his message was even less reassuring; it ended with "Please pray for everyone."

CAMP 1, EVEREST

The Summit Climb expedition had left Base Camp and made its way through the Khumbu Icefall earlier that morning. McKnight was climbing with a team of 17. They were feeling strong after making it through the icefall. Still, when they reached Camp 1—which sits at 19,800 feet—they were struck by the area's precarious glaciology. The team camped just beneath the southeast face of Everest. On both sides loomed sheer walls and immense hanging seracs.

McKnight settled into his tent alongside a Finnish teammate. All of a sudden the tent started moving up and down and side to side. McKnight experienced a great heaving of earth—only he was on a great block of ice. The glacier was shifting beneath him. Mazur, the guide, started screaming, "Get your ice axes! It's coming!" He instructed the team members to lie on their bellies with their axes planted in the ice. Then the avalanches started: one, two, three. They were aerosol avalanches—wind-driven thin layers of snow. They didn't carry the type of deadly mass of rock and ice that struck Base Camp. Still, the power of the air that funneled through Camp 1 was wild, a live, 120-knot thing turned fierce by the snow and vapor it carried. McKnight, a sailor who has navigated through hurricanes, had never felt air moving so ferociously. He was facing uphill when the winds hit, and the air pressure forced his lower body around his ice ax. He was covered by 8 inches of snow, and as he cleared an airway, he braced for the inevitable crashing serac and subsequent slide that he was fairly sure would end his life on Everest.

The big slide never came. Immediately following the quake, Mazur decided to relocate to the center of Camp 1, away from the looming seracs. The center of Camp 1 is made up of a series of ice ridges; Mazur picked one that was about 25 by 50 feet. Starting that afternoon they got hit by one aftershock after another, deep seismic shifts that sounded like great grinding gears of ice. This was about the time Mazur sent his tweets, asking for prayers.

McKnight awoke the next morning, Sunday, to sun and a steady influx of helicopters. People were lining up to get on the first flights out of Camp 1, and from the ridge above he could see groups of climbers making their way down from Camp 2, at 21,500 feet. When he called Kathy on his sat phone, he had no idea about the extent of the devastation in Nepal. Kathy told him that an avalanche had killed people at Base Camp and that the low-lying regions outside Kathmandu were devastated; McKnight began to realize his team's lot. The government would be deploying aircraft far from the Khumbu, and the avalanche had destroyed the fixed ladders and ropes that might have allowed a climbing descent to Base Camp. Still, he told Kathy not to do anything—he figured they had enough food and fuel to melt snow for water for a few days, and he even held out a sliver of hope that the team might complete their ascent.

On Sunday, Camp 1's tiny airstrip became a traffic hub to rival a LaGuardia runway. A constant stream of helicopter flights landed that day, shuttling climbers down the mountain. Nepal's high-altitude helicopter operators had all dispatched their aircraft to the Khumbu region. The matter of who boarded the flights was hardly scientific: Access to the helicopters was determined by personal relationships between operators and climbing guides. Occasionally, though, force did the trick. A few members of the Summit Climb team were anxious to leave, so Jangbu Sherpa, one of Mazur's trusted staff, shouldered his way in and pushed them on a flight.

MOUNT EVEREST BASE CAMP

On April 25, 2015, Sherpas, climbers, and rescuers carry an avalanche victim. Pasang Sherpa searches through flattened tents for survivors. A helicopter lands to pick up the injured on April 26.

THE MOUNTAINS SHUDDERED WITH AFTERSHOCKS. MORE OMINOUSLY, THE FORECAST CALLED FOR A STORM TO SOCK IN THE REGION, WHICH WOULD RENDER HELICOPTERS USELESS.

COURTESY OF **PATRICK MCKNIGHT**

EVEREST CAMP 1

This Fishtail Air helicopter is one of a limited number capable of flying at high altitudes in the Himalayas.

After the earthquake, it made dozens of flights to transport more than 100 climbers to Base Camp.

Kathy McKnight, though, was ready to make contingency plans. She knew that the forecast called for a storm that might sock the region in, rendering helicopters useless. She also knew that her husband and one other person on his team, a Scot named James Grieve, had memberships with Global Rescue. On Monday morning Kathmandu time—Sunday night in Virginia—her husband called again. This time the couple made the decision to call Global Rescue for an evac. Some 150 people had been evacuated from Camp 1, but the Summit group hadn't made it onto a helicopter, and the storm was closing in. Kathy called Global Rescue, connecting with Jeff Weinstein, a paramedic in Bangkok who immediately contacted Shree Hari Kuikel, the operations manager at Fishtail Air, one of six helicopter companies Global Rescue regularly works with in Nepal. That day the government had announced it was taking control of all aircraft, but Kuikel said he could get a helicopter to Camp 1 the following day, during a down period between government-mandated flights. That night, Weinstein spoke with Patrick via sat phone. "He said, 'Don't sweat it, we're there,'" McKnight recalls.

The next day, Fishtail dispatched a helicopter from Lukla to Camp 1. When the pilot arrived, Camp 1 was shrouded in a fast-closing cloud bank. He figured he had a 45-minute weather window to perform the evacuation. McKnight pulled out his Global Rescue card and flashed it to the pilot, who gave him a thumbs-up. Soon McKnight and Grieve were in the air. Over the course of the next hour, the pilot shuttled the remaining members of the Summit Climb team to Base Camp. Mazur made the climbers pair up with Sherpas, who often get left off helicopter medevacs because they can't pay. No other option was considered; leaving someone up there could have been akin to manslaughter. They were the last team in camp.

The group spent the night in Base Camp, gathering what was left of their gear. The next day, the Fishtail pilot shuttled them down to Lukla. McKnight and Grieve shared the helicopter with a corpse, a Nepali man who had died in the Base Camp avalanche. There was precious little room in the helicopter, so the team sat on the cold body. Anderson met them when they landed, and they had tickets home within a matter of days.

"I have nothing but the utmost respect for Global Rescue," Patrick McKnight tells me. "I sound like an ad rep, but whatever I paid, I'll pay it every year. Because I sure as hell don't want to be up there without it."

Disaster zones are both collaborative and competitive places. International search-and-rescue organizations come first, followed by the big aid operations—USAid, the Office of the United Nations High Commissioner for Refugees, the Red Cross. Their mission is altruistic but not selfless. The groups give aid and also vie for certain resources: access, local knowledge, hotels, helicopters, publicity. The same holds true for the private crisis-response industry. One day Weinstein ran into a former Global Rescue employee who now works for Redpoint. The two were cordial, but at the time there were a limited number of private helicopters operating in Nepal. Both Redpoint and Global Rescue wanted access to them. Both companies acquitted themselves admirably under the conditions, and both evacuated numerous clients, as well as bystanders. Global Rescue flew Summit Climb's Sherpas down from Camp 1 at no cost, while Redpoint sent a trauma surgeon to tend to rural villages. "These companies will help out if they have extra room on the plane," says John Moretti, a former PR manager for Global Rescue. "And if they get some publicity, all the better. But at the end of the day they're private companies. They're not there to do the government's job."

In the days following the quake, Global Rescue's team was divided. Weinstein, the paramedic who took Kathy McKnight's call, flew into Nepal to join Anderson in Lukla, where the two tended to the last of the descending clients. Fraser and Pache, meanwhile, stayed in Kathmandu, remaining on call in the event a client needed help. One night, during dinner in Kathmandu, I ask if they had thought of heading into the hard-hit mountain villages to help. "We're not equipped, we're not manned, it's beyond our scope," Pache says.

"Beyond the initial humanitarian effort we made, our focus has to be on our members," Fraser says. Then he pauses and says, "Obviously, as medics and rescue workers, it's frustrating to watch."

The next morning, I go to visit Ben Ayers, Nepal country director of the dZi Foundation, a nonprofit group that works on issues like rural school safety and porter welfare in Nepal. The day after the earthquake, Ayers helped Fraser triage those patients in Lukla. Ayers has a deep respect for Fraser, but he takes issue with the role groups like Global Rescue play in Nepal. "There is the issue of those flights going to pick up wigged-out tourists," he says, "instead of going to pick up really fucked-up people in Ghorka"—the epicenter of the quake, where the damage more closely resembled that caused by a tsunami. The fact that Global Rescue was able to commandeer such precious resources, though, came as little surprise. "This is a place where money talks," he says. "It's a feudal kind of society."

Later, I bring this up with Richards. How, I ask, does he justify Global Rescue's role in commandeering helicopters? "These are difficult issues to deal with," he says. "Especially when you're trying to navigate a terrible catastrophe, and you're trying to determine who gets incredibly scarce resources. It's hard to say that there were others that in the first 36 to 48 hours more desperately needed the services than the climbing community. To try to compare levels of need is a really hard thing to do."

He also says, "We always leave these situations wishing we could have done more. When it comes to our clients, though, we feel pretty good about how we've been able to support them."

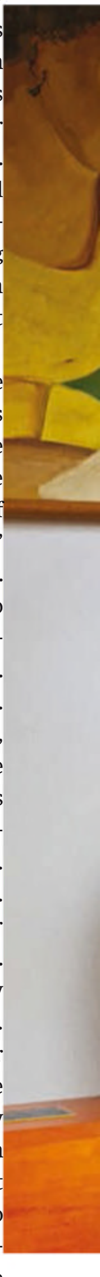
By Sunday, May 3, most of the climbers and trekkers had left Lukla, and the town's teahouses and lodges were empty. Anderson, though, had one more operation to wrap up before returning to his post in Bangkok: He accompanied a helicopter to pull Johnson, who had a bulging disk, off Makalu. Anderson then stuck around the mountain town for two more days. While there, he went to the damaged hospital to speak with a young doctor he'd met. The doctor, who was Swiss, was seeing a patient. A Nepali man who appeared to be in his late thirties, he had fallen and hit his head in the mountains and was suffering from severe seizures. The doctors were trying to keep him mildly sedated while members of his family attempted to prevent him from ripping out his IV. Anderson quickly recognized that the man needed a CT scan and probably surgery. All signs pointed to a brain bleed. But the Swiss doctor told Anderson that the man would have to wait.

"What for?" Anderson asked. The doctor said it would cost $3,000 to fly the man to Kathmandu, the only place capable of addressing his needs, but the patient didn't have enough money. No helicopter companies would fly at a reduced rate.

"Here's a guy lying there," Anderson tells me later, "and just because he can't afford it, he's probably going to die. After watching all these well-to-do individuals clamoring to get on these flights, I'm thinking, 'He truly needs to get out of here. And no one knows, and no one even cares.'"

This was an impossibly difficult situation. Global Rescue can't reasonably be expected to offer pro bono flights to every victim it encounters. As Richards says, it's not the Red Cross. Still, the experience affected Anderson deeply. "It's difficult," he says. "With our background, we want to get in there. We want to help." The patient made it to Kathmandu the next day. His family reported he'd survived. Whether he'd suffered permanent damage was anyone's guess. Neither the doctor nor Anderson knew his name.

Shortly after the Nepal operation, Fraser handed in his resignation to Global Rescue. The move was largely personal—he and Becky planned to marry and wanted to be together. He told me that he would continue to work for Global Rescue on a contract basis, and that he was grateful to the company for the opportunity to triage those patients in Lukla. "GR put me in that position," he told me. "I will never forget that." He also said he was planning to return to sub-Saharan Africa, where he and Becky are starting a nonprofit that provides health care to the needy at no cost. He couldn't wait to get back.



> “HERE’S A GUY LYING THERE,” ANDERSON SAYS, “AND JUST BECAUSE HE CAN’T AFFORD IT, HE’S GOING TO DIE. HE TRULY NEEDS TO GET OUT OF HERE. AND NO ONE KNOWS—NO ONE EVEN CARES.”

PHOTOGRAPH BY **MATT EICH**

HASSAN ANDERSON

Senior specialist Anderson flew from Global Rescue’s Thailand Operating Center in Bangkok to Kathmandu in order to assist in the company’s response to the April 25 earthquake.

Secret Weapon

CONTINUED FROM PAGE 83

slot in the pins to attach the upper receiver—a component that looks much more like a gun than the lower receiver does and whose total lack of regulation is, frankly, bizarre—they make a pleasant *chink*. My AR-15 is complete.

I look down at the fully built rifle and something in my brain shifts. I realize that the abstract parts I'd been fiddling with have turned into an object capable of killing someone. My lower receiver has transformed from a "gun" in a legal sense to a "gun" in a very practical sense.

I remember that I should start being careful where I point it.

FIRE AT WILL

THREE DAYS LATER, at a shooting range across the Bay Bridge, I load my AR-15 with a 10-round magazine of .223-caliber ammunition to fire it for the first time. I pull the trigger hesitantly as I aim at a piece of cardboard 20 yards away. The deafening blast silences the tweeting of nearby birds and echoes around the range's wooden walls as the rifle's stock digs into my shoulder. I can see a tiny hole in the cardboard. A plume of dust rises from the dirt berm behind it.

"Well, it goes bang," says Rynders, who came along to the range.

I fire again. Then three more times. Then I empty the magazine. Then I reload and empty another one.

Halfway through the next magazine, I pull the trigger but get nothing except a soft click. The range officer, who happens to be a winner of the shooting-competition reality TV show *Top Shot*, diagnoses that there's a jam in the upper receiver and it needs to be lubricated—a common problem with new rifles. He opens it, douses the bolt and buffer parts with lube, then reassembles the gun.

My rifle performs perfectly for the rest of the morning.

THE DAY AFTER that shooting field trip, I have a flight home to New York. Taking my ghost gun on a plane—legally three ghost guns, in fact, since I created three lower receivers—seems unwise. I can't leave them in WIRED's office in San Francisco, either, because that might count as transferring ownership of the unserialized guns, which could be a felony. I consider destroying them with a hacksaw, but ATF regulations that I found online seem to demand the lower receiver be destroyed with a blowtorch, removing enough metal that it can't possibly be welded back together.

So instead I decide to surrender my three lower receivers to the local police. I disassemble my AR-15 and leave a large box containing all the parts except the lower receivers on my editor's chair. Then I walk down the street to the police station in San Francisco's SoMa neighborhood and tell the lady at the front desk I want to hand over some firearm components. She gives me a puzzled look and asks me to sit down.

Forty minutes later, two cops emerge from a door and ask what I'm doing there. I explain and show them the three lower receivers. They examine them with expressions that are simultaneously quizzical and bored. I ask them if it is common to see AR-15 lower receivers like these: homemade, with no serial numbers. "I've never seen this before," one of them says.

The cops give me a handwritten receipt for the three weapons, as if to definitively show that these are no longer outside law enforcement's awareness or control: They now have a number. Then they take my lower receivers behind their locked door, and I say good-bye to my ghost gun.

The Ghost Gunner still sits in a storage room at WIRED's office a few blocks away. It's ready to make another lower receiver at any time. And Defense Distributed has already sold more than a thousand of its gun-making boxes, each one a tiny, easy-to-use, anarchic rifle factory.

In other words, to paraphrase the Rifleman's Creed again, this ghost gun was mine. But there will be many like it. ▣

COLOPHON

MUTATIONS THAT HELPED GET THIS ISSUE OUT:

A seafood allergy; a *Penicillium* allergy (no blue cheese for me); upside-down elbows; the ability to lick my elbow; grapheme-color synesthesia; aesthetic synesthesia; my two and a half wisdom teeth; my clubfoot; being born a month late; being born a month early; an extra bone in my right toe; some sort of calcified mass in my right knee; Hillary Clinton's #brand; 1984 Alfa Romeo GTV6 with a 164L engine and Milano transaxle; eating oranges and lemons whole, peel and all; fingerlike toes, allowing me to grip objects; my (evolved) sexuality; the Bay Area's transition from summery May to wintry June; *ABCC11*; if I shift my eyes really fast, I see smoky black streaks; the Rash.

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NOTICE FOR PUBLICATION OF SALE AND DISPOSITION OF COLLATERAL

To: Advanced Mobile Software, LLC ("**Borrower**")
From: ParentsWare, Inc. ("**Secured Party**")
Sale Date: August 17, 2015 **Time:** 10:00 a.m. (PDT)
Place: Stradling Yocca Carlson & Rauth, P.C.
4365 Executive Drive, Suite 1500, San Diego, CA 92121

This Notice of Sale and Disposition of Collateral ("**Notice**") is given pursuant to the Delaware Uniform Commercial Code and other applicable law, if any (collectively, the "**UCC**"). On the date, time and place set forth above, Secured Party or its designee/assignee will offer at public sale, for auction to the highest bidder, the Collateral (as defined below). Such Collateral consists of all right, title and interest of Borrower in and to 1,694,398 common shares of ParentsWare, Inc. a Delaware corporation (par value of $0.001 per share) of which Borrower is the record holder, all as more particularly described on Exhibit A (the "**Collateral**").

THE COLLATERAL CONSISTS OF UNREGISTERED COMMON SHARES IN PARENTSWARE, INC. ("STOCK"). THE STOCK IS BEING OFFERED PURSUANT TO A "PRIVATE PLACEMENT" EXEMPTION AS ALLOWED UNDER THE SECURITIES ACT OF 1933 AND AS A "PUBLIC DISPOSITION" AS ALLOWED BY UCC SECTION 9-610. NO GENERAL SOLICITATION OF INVESTORS IS INTENDED PURSUANT TO THIS NOTICE.

THE SECURED PARTY RESERVES THE RIGHT TO TAKE ANY ACTIONS NECESSARY TO PRESERVE THE "PRIVATE PLACEMENT" EXEMPTION OF THE PROPOSED SALE AND WILL ACCEPT BIDS ONLY FROM "ACCREDITED INVESTORS" AS DEFINED IN RULE 501 OF REGULATION D PROMULGATED UNDER THE SECURITIES ACT OF 1933. PLEASE NOTE THAT THE SECURED PARTY RESERVES THE RIGHT TO BID ON THE COLLATERAL.

THE STOCK COMPRISING THE COLLATERAL HAS NOT BEEN AND WILL NOT BE REGISTERED WITH THE SECURITIES AND EXCHANGE COMMISSION ("SEC") OR ANY SIMILAR STATE BODY PRIOR TO THE SALE. THE STOCK WILL BE OFFERED IN ACCORDANCE WITH APPLICABLE LAW.

THE SECURED PARTY IS NOT ACTING AS AN "ISSUER" AND MAKES NO REPRESENTATATIONS OR WARRANTIES AS TO THE COLLATERAL AND/OR THE STOCK AND/OR PARENTSWARE, INC.

Reference is made to the letter dated May 21, 2015, circulated by Stradling Yocca Carlson & Rauth, P.C., as counsel to Secured Party, to Borrower ("**Notice of Default**"), the Secured Promissory Note dated May 6, 2014 ("**Secured Note**"), and the Stock Pledge Agreement dated as of May 6, 2014 ("**Stock Pledge Agreement**"). Pursuant to the Secured Note and the Stock Pledge Agreement, Secured Party was granted a security interest in the Collateral.

The Borrower is obligated to Secured Party under the Secured Note and the Stock Pledge Agreement for payment of principal in the amount of $270,000 plus costs of collection and enforcement, including, without limitation, attorney's fees.

Secured Party will accept bids on the Collateral upon the following terms and conditions:

1) **All parties that intend to bid at the public auction sale must pre-qualify by providing to Secured Party a cash deposit or a letter of credit in the amount of $20,000 ("Deposit"), which must be received by Secured Party on or before 5:00 p.m. PDT on August 7, 2015**. The form of the letter of credit for the Deposit must be acceptable to Secured Party and its counsel in their sole discretion. The Deposit of the non-successful bidders will be refunded and/or returned to such non-successful bidders. The Deposit of the successful bidder will be retained by Secured Party and applied against the successful bid, or in the event that the successful bidder fails to complete the sale, shall be forfeited to Secured Party.

2) **BECAUSE THE SALE IS BEING MADE PURSUANT TO A "PRIVATE PLACEMENT" EXEMPTION: (1) ONLY "ACCREDITED INVESTORS" MAY BID ON THE COLLATERAL AND EACH BIDDER MUST VERIFY IN WRITING AND PROVE TO THE SATISFACTION OF THE SECURED PARTY THAT THE BIDDER QUALIFIES AS AN "ACCREDITED INVESTOR"; (2) EACH BIDDER WILL REPRESENT IN WRITING THAT IT IS TAKING THE STOCK FOR ITS OWN ACCOUNT AND NOT WITH A VIEW TOWARDS THE SALE OR DISTRIBUTION OF THE STOCK; AND (3) EACH BIDDER WILL ACKNOWLEDGE IN WRITING THAT THE STOCK IS SUBJECT TO TRANSFER RESTRICTIONS AND WILL BEAR AN APPROPRIATE LEGEND TO THE EFFECT THAT THE STOCK MAY NOT BE SOLD OR TRANSFERRED WITHOUT REGISTRATION, UNDER THE SECURITIES ACT OF 1933 AND APPLICABLE STATE LAWS, OR THE AVAILABILITY OF A VALID EXEMPTION FROM SUCH REGISTRATION. COLLECTIVELY (1)-(3) HEREIN ARE THE "BIDDING QUALIFICATIONS".**

3) Secured Party reserves the right to postpone or renotice the time, date and/or place of the sale. Secured Party reserves the right to sell the Collateral in lots, bulk, or as individual items. If competing offers with different terms and conditions are submitted, Secured Party reserves the right to determine which offer shall be accepted, and its decision in this matter shall be final.

4) Secured Party shall not be obligated to make any sale pursuant to this Notice, and reserves the right to reject any and all offers at its sole discretion for any reason whatsoever.

5) The sale of the Collateral shall be made without warranties or representations of any kind by Secured Party, including, without limitation, any warranties or representations as to title, fitness for a particular purpose, or any other facts or matters and shall be made on an "as is where is" basis.

6) Secured Party reserves the right to bid (even if by way of a "credit bid" or set off) at the sale or any continuation or adjournment thereof.

7) The sale will not be complete until the successful bidder delivers to Secured Party or its counsel cash, cashier's check, or immediately available funds in the full amount of the successful bid (net of the Deposit). Notwithstanding the foregoing, Secured Party may, but shall not be required to, allow the successful bidder up to two (2) business days to deliver the full payment as set forth above. In case the successful bidder fails to complete the purchase within the time allowed, the Collateral may thereupon again be offered for sale without further publication or notice. In the event of a failure to complete the purchase, the bidder will not be relieved of liability to complete the purchase, and the bidder's Deposit will not be refunded.

8) The above terms and conditions of sale may be supplemented or amended by Secured Party at any time prior to the sale.

9) The Borrower is entitled to an accounting of the unpaid indebtedness secured by the Collateral. The Borrower may request an accounting by contacting James O. Thoma of Stradling Yocca, Carlson & Rauth, a Professional Corporation, counsel for Secured Party, at 100 Wilshire Blvd., 4th Floor, Santa Monica, CA 90401; telephone number: (424) 214-7000; facsimile number: (424) 214-7010; e-mail: jthoma@sycr.com.

Qualified individuals or companies interested in bidding at the sale should contact Mr. Thoma to arrange for review of the due diligence materials, which are comprised of a copy of the Notice of Default, a copy of the Secured Note, a copy of the Stock Pledge Agreement and a copy of the Stock certificate ("**Diligence Materials**"). Any parties seeking to review the Diligence Materials may be required to execute a Non-Disclosure Agreement (which may include provisions relating to the Bidding Qualifications) prior to such review.

Dated: James O. Thoma, Esq. • Stradling Yocca Carlson & Rauth, P.C.,
June 12, 2015 Attorneys for Secured Party, ParentsWare, Inc.

EXHIBIT A: COLLATERAL

The Collateral consists of 1,694,398 shares of the Common Stock of ParentsWare, Inc. (par value of $0.001 per share) represented in a single stock certificate Number C-1 issued to Advanced Mobile Software, LLC as record holder on May 6, 2014.

WIRED INSIDER PROMOTIONS + SPECIAL OFFERS + EVENTS

THE GREEN GURU: THE GEICO GECKO UNCOVERS HOW THINGS WORK

Your phone doesn't stay charged as long as it once did. Where'd the juice go?

Out of the box, your phone lasted a full day on a charge. Now you're lucky if it makes it to lunch. Why is it draining faster than it did before?

Many gadgets are powered by a lithium-ion (Li-ion) battery. With these batteries, the simple answer is age. The number of charge cycles and heat exposure can speed up deterioration.

Inside the battery, lithium ions move from a positive electrode to a negative one during charging. When you're using the battery, they reverse flow from the negative electrode to the positive. But the more you charge, the more the process starts to erode. Like high-tech cholesterol, crystals build up within the battery, impeding the flow of ions.

Many manufacturers recommend storing your devices at around 59°F. Keeping devices in warm places—like a hot car—could contribute to the decline. Even though some of your oldest gadgets can't make it through a 15-minute call to GEICO, these tips could help save your next smartphone—and 15% or more on car insurance

geico.com

GEICO.

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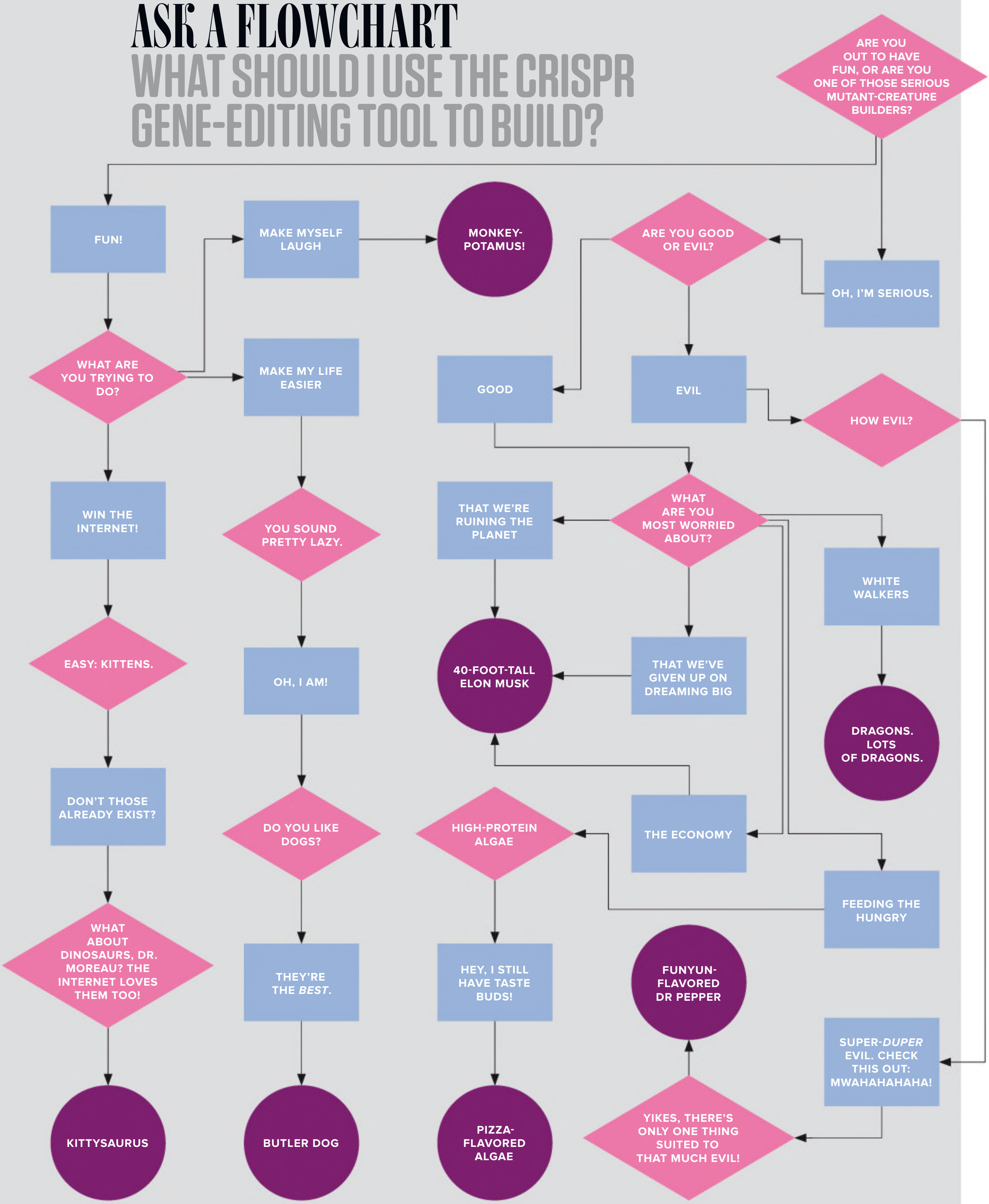
BY ROBERT CAPPS

ASK A FLOWCHART

WHAT SHOULD I USE THE CRISPR GENE-EDITING TOOL TO BUILD?


ARE YOU OUT TO HAVE FUN, OR ARE YOU ONE OF THOSE SERIOUS MUTANT-CREATURE BUILDERS?
FUN!
WHAT ARE YOU TRYING TO DO?
MAKE MYSELF LAUGH
MONKEY-POTAMUS!
MAKE MY LIFE EASIER
YOU SOUND PRETTY LAZY.
OH, I AM!
DO YOU LIKE DOGS?
THEY'RE THE *BEST*.
BUTLER DOG
WIN THE INTERNET!
EASY: KITTENS.
DON'T THOSE ALREADY EXIST?
WHAT ABOUT DINOSAURS, DR. MOREAU? THE INTERNET LOVES THEM TOO!
KITTYSAURUS
OH, I'M SERIOUS.
ARE YOU GOOD OR EVIL?
GOOD
EVIL
HOW EVIL?
WHAT ARE YOU MOST WORRIED ABOUT?
THAT WE'RE RUINING THE PLANET
40-FOOT-TALL ELON MUSK
THAT WE'VE GIVEN UP ON DREAMING BIG
WHITE WALKERS
DRAGONS. LOTS OF DRAGONS.
THE ECONOMY
FEEDING THE HUNGRY
HIGH-PROTEIN ALGAE
HEY, I STILL HAVE TASTE BUDS!
PIZZA-FLAVORED ALGAE
SUPER-*DUPER* EVIL. CHECK THIS OUT: MWAHAHAHAHA!
YIKES, THERE'S ONLY ONE THING SUITED TO THAT MUCH EVIL!
FUNYUN-FLAVORED DR PEPPER

The completely redesigned 2015 Edge is here and ready for almost anything, with available features like a front 180-degree camera, enhanced active park assist and Lane-Keeping System. It's comforting to know you have a few surprises of your own. Go to ford.com to find out more.

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